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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

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Practical Papers

Once again we see the suggestion being put forward that the scientific institutions, in this case the Institute of British Foundrymen, do not have in sufficient quantity a good practical type of Paper. This is no new complaint, and it is heard periodically in the other institutions, which find the same state of affairs; good practical Papers are very difficult to get. We may assume that a practical Paper is one which simply presents the results of experience, in connection with some aspect of foundry work. A Paper may deal with some such practical aspect in a purely general and theoretical way, but this does not appear to be what is required, as an outstanding recent case amply proves.

The reasons for the dearth of good practical Papers are readily understood. The practical side of foundry work has been developed in this country now for over a century, and much that can be said has been said. The craft does not, after all, change very rapidly. Secondly, the practical man who spends his life gaining experience, which is his capital, does not always want to present it to the world at large. He is more concerned with his reputation as it appears to his employer than as it appears to the outside world. Thirdly, the practical man often has difficulty in formulating his ideas on paper. He does not run to words so readily as his scientific friend.

There appears to be an impression that the deficiency can be made good by bludgeoning suitable people into writing and presenting such Papers, but experience suggests that the best Papers are seldom so obtained. A Paper should only be written when its author feels that it must be written. Since they are so few, they should be kept for the annual conference. Since scientifically-trained men do express themselves more readily, many useful practical Papers might be the outcome of collaboration between a practical man and a scientific man, the former providing the experience and the latter the mode of expression, the evaluation of the evidence, and so on. One of the earliest Papers presented on yellow metal diecasting remains one of the best, and was written by such a combination. Finally, the Iron and Steel Institute has doubtless found the presentation of practical Papers stimulated by the offer of a suitable prize, in this case the Williams prize.

A Promise Fulfilled

A few years ago we very strongly advocated the creation of a number of technical committees for the co-operative study of various phases of foundry practice by the Institute of British Foundrymen. This was acted upon with commendable enterprise by the Council and energetically by its younger members. The Malleable Cast Iron Sub-Committee reported its findings in 1932, the "Sands" Sub-Committee in 1933, and this year there is to be a Report by the Grey Iron Sub-Committee. The reports have definitely recorded the existing state of the art and science, and future tendencies, reinforced by experimental evidence made by the members of the committees. The outstanding benefit which industry derives from these activities is the information gained by the participants. By periodically meeting other men engaged on problems akin to their own, the members acquire a much more profound knowledge of their industry than would be otherwise possible. Thus the general level of technical efficiency throughout the whole industry is raised. Committees to be manageable must be kept within reasonable proportions, and this, unfortunately, limits the benefit which industry can gain from this aspect of personal participation. No valid reason, however, exists why more sub-committees should not be set up, and the Institute would welcome suggestions from groups of members or manufacturers as to the nature of any specific branch of foundry practice upon which a sub-committee could usefully study and eventually report. At the moment, the phases covered are grey iron, malleable, non-ferrous, steel, sands and refractories, melting furnaces and costing. This is a fairly comprehensive list, but there are other activities, such as materials handling, protective coatings, and nomenclature which would appeal to certain sections of the industry and which, obviously, are important. It can be asserted, without fear of contradiction, that the formation of technical committees has been so successful as to form to-day one of the major activities of the Institute's work. It has merited and achieved a great initial success, and is fortunate in having attracted to it a highly-efficient band of, for the most part, young men. This is the surest guarantee of the continuance and extension in the near future of the work so admirably begun.

This activity, associated with the creation of Branches and sections has probably resulted in about 10 per cent. of the members being actively employed in some executive position or having sampled the fruits of office at some time or other. This compares with but 1 to 2 per cent. maximum with most other scientific bodies. A pursuance of this policy of getting the personal practical interest of a maximum number of members has indeed much to commend it.

XUM

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cupola Practice

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I must apologise to Mr. Neville for delay in replying to the points raised in his letter of April 13—published in your issue of April 19—largely owing to my desire to furnish data from more recent balanced-blast cupola practice.

In the first place, I must thank Mr. Neville for pointing out a clerical error in my letter of April 5, where the analysis of the ideal neutral gas in the region of the main tuyere-valve horizon was incorrectly given and should have been as under:—

CO_2	CO.	N_2.	Ratio CO_2/CO.
Per cent.	Per cent.	Per cent.	
9.4	18.8	71.8 by volume ..	0.50
14.0	17.8	68.2 by weight ..	0.78

I used the term "hearth gases" as representative of the gases formed in the region of the lower two rows of tuyeres; just as the same term is often used as descriptive of the gases in the blast-furnace hearth just above the tuyere level—where the aim is to produce a reducing gas of the composition CO 34.3 per cent., N_2 65.7 per cent.

In the balanced-blast cupola the hearth gas is that formed between the horizon of the bottom (valved) tuyeres and that of the lowest row of auxiliary tuyeres, where the first addition of supplementary air is able to convert a portion of the CO in the hearth gas to CO_2. At the next row and, when required, the third or top row of auxiliary tuyeres, the further additions of supplementary air progressively convert the remaining CO in the rising hearth gases to CO_2.

It is quite true that the vertical distance between the three or four rows of tuyeres is an important factor, and this was found by trial in the long series of tests under melting conditions of the first balanced-blast cupola. Since then variations in the levels of the auxiliary tuyeres relative to the main valved tuyeres have been tried in a number of cupolas—without finding any serious difficulty in adjusting the air supply through the auxiliary tuyeres such that the ultimate analysis and temperature of the top or waste gases were reasonably near the ideal.

The design of the tuyere grouping has been made to enable the air supply to be adjusted to suit the varied conditions required, and, as must be expected, practical experience has shown that the wide range of possible air adjustments at each and all the tuyere horizons includes a discoverable optimum narrow range of adjustments which, so far, has not been fixed entirely by calculation—being guided by metal temperature, rate of melting, and top-gas data obtained from many trials.

Mr. Neville suggests that "reactivity" and "combustibility" variations in different cupola cokes may seriously affect the air-control factors.

As a member of the different Coke Research Committees almost from their inception, I have followed the investigations on cupola cokes with great interest, particularly those relating to the reaction to CO_2 and to oxygen (combustibility)—and to the influence of coke size and hardness in balanced-blast cupola practice.

It is perhaps too early yet to express definite conclusions on these properties of coke as affecting cupola practice, but, as both blast-furnace and foundry cokes have now been very thoroughly tested, there would seem to be very little difference in the specific reactivity, at hearth temperatures, of the cokes in general use by British foundrymen, though combustibility, as measured by the CO content in the top gases, may vary with different rates of air supply.

If, therefore, the reactivity and combustibility of cokes at high hearth temperatures vary so little, the actual experimentally-found values of those two properties of foundry cokes cannot seriously affect the air adjustment range in the balanced-blast cupola when using any of the well-known British cupola cokes.

Mott and Wheeler ("Coke for Blast Furnaces") state that "the size and hardness of a coke affect the hearth conditions more than does its specific reactivity."

The physical properties associated with the size and hardness of coke affect the rate of coke-burning and the maximum temperature produced in the coke bed. Suitably to control these conditions in the balanced-blast cupola both the main valve in the fan duct and the adjustments of the valved and auxiliary tuyeres are at hand. The optimum ratio between the volumes of air passing through the main and auxiliary tuyeres, found by experience, can deal effectively with variations in coke reactivity, whilst the main blast valve, by controlling the rate of coke-burning and metal-melting, deals with the variations in coke size and hardness.

With reference to my statement that in the ordinary cupola the maximum rate of melting occurs in an annular zone in the outer half of the cupola, might I point out that in Mr. Neville's Fig. 1 the form of the "Belden" curve BCDEF, which is the limiting surface of the ascending gas streams containing free oxygen, is also coincident with the level of temperature-maxima across the coke-bed section? The CO_2 contents of the gases at these levels are roughly proportional to the heat generated per pound of air present in the gases (as estimated) and to the corresponding temperature intensity. The higher CO_2 contents in the gases are indicative of higher air consumption as the curve BCDEF approaches B and, as roughly the distance B to C represents in Belden's experiments half the cupola bore area, it follows that the greater proportion of the air supplied to the cupola is used in the outer annular half, where, being converted to CO_2 in the reaction with carbon, the result is a higher melting rate.

It may be of interest to your readers to learn that, in recent long runs with a 54-in. bore balanced-blast cupola the mean analysis of the top gases, from samples taken on two separate days, was as shown below:—

CO_2	CO.	Ratio CO_2/CO	
Per cent.	Per cent.		
18.5	1.4	13.2 : 1	(A) CO_2 and CO per cents by volume.
13.5	7.3	1.85 : 1	(B)

At B the analysis of top gases from a companion cupola of ordinary type and giving good results is of interest.—Yours, etc.,

J. E. FLETCHER.

Netherton Iron Works,
Dudley.

May 5, 1934.

World Tin Consumption Rising

A 28 per cent. increase in world tin consumption for the year ended February, 1934, compared with the previous year, is shown in the April bulletin of The Hague Statistical Office of the International Tin Research and Development Council. Tin consumption during the twelve months, it is shown, amounted to approximately 128,000 tons, as compared with 99,833 tons during the twelve months ended February, 1933, and with 129,003 tons during the twelve months ended February, 1932. A considerable increase in the world production of tinplate is also shown. Tinplate production during the twelve months ended February, 1934, the Bulletin states amounted to approximately 3,150,000 tons, as compared with 2,290,000 tons during the twelve months ended February, 1933.

Random Shots

A massive parcel stands in our office, its bulk an obstacle to the hordes of puzzled readers who daily seek us out for information on this, and occasionally that, subject. Coyly nestling in layers of brown paper is the indicator of a General omnibus. At present a mere shell, it may some day guide wayfarers to Barking or Blackheath. Just now it guides no one. But, although of little use to man or beast, except as an example of good sheet-metal work and spot welding, it has given "Marksman" an idea.

* * *

Briefly, my idea is this: A large number of firms making the component parts of omnibuses (who was the mistaken pedant who called them omnibi?) will be approached tactfully, and, no doubt, in exchange for valuable advice on their plant or manufacturing methods, the firms will give me samples of their wares. From one company will come a gearbox, from another a rear lamp, from a third a windscreen wiper, and so will arise a large six-wheeler omnibus of my very own. "Marksman" would then qualify for a full page in the Sunday newspapers as the only owner-driver of a private six-wheeler. The possibilities of such a possession are unlimited. No Lord Mayor in his gilded coach could ride in greater state than "Marksman" in the rear top seat of his chauffeur-driven private omnibus (L.G.O.C., or I should say L.P.T.B., type). Think of the pleasure one could get driving down Oxford Street during the spring sales, violently rejecting indignant shoppers who try to board the 'bus. What would the purple colonel say, after a successful hundred-yards sprint in pursuit, when I told him I had just come out to buy a packet of cigarettes and was turning back now? Imagine the sensation at the Duchesses' garden party when I roll up the castle drive! Picture the general mirth of an assorted crowd of suburban passengers, when I let them take their seats and then roar off to John O'Groats, first stop Carlisle.

* * *

We have a good indicator. All we want now is the rest of the 'bus.

"MARKSMAN."

Catalogues Received

Grinding Equipment. Messrs. Alfred Herbert, Limited, Coventry, as sales agent for the Norton Grinding Wheel Company, Limited, have sent us the December issue of "Grits and Grinds," which contains descriptions of six new grinding machines. These include a motorised tool and cutter grinder, a small hydraulic surface grinder, cylindrical grinders, the "Nortonizer"—an automatic electrical sizing device, a crank-pin grinder and the "Cam-O-Matric" for grinding automobile camshafts on a quantity-production basis.

Plumbago. The Morgan Crucible Company, Limited, Battersea Works, London, S.W.11, have recently prepared an eight-page pamphlet specially devoted to "Plumbago for Foundry Purposes." The pamphlet is definitely utilitarian, and is a plain, well-written statement dealing with the practical uses of plumbago in various phases of foundry practice. *Inter alia*, a number of recipes, drawn from practice, are given as useful pointers.

Non-Ferrous Fluxes. During a recent visit to England, Mr. Leeb, of 2, Aegidig 36, Linieng, Vienna 6, presented us with a 28-page booklet which he calls "Rational Melting." It is in German, and covers the use of a number of proprietary alloys, fluxes and pattern compounds, but in addition contains a number of useful hints to those engaged in the non-ferrous and light-alloy foundry industry.

Production Costs and Selling Prices

By W. A. Hodson, A.C.I.S.

In this Paper the Author outlines the fundamental principles of a good Costing System and the effect of a knowledge of Costs on Selling Prices. It was read before the Lancashire Branch of the Institute of British Foundrymen, Mr. A. Phillips presiding.

There are many foundrymen who on receiving an inquiry for castings give careful consideration to the drawing or the patterns, and by calculation prepare an estimate of the time which should be taken in the making. On the other hand, there are those who make a guess at the price, irrespective of what the estimated cost may be. After the quotation has been submitted, the one who has prepared the estimate will understand the feeling, sometimes of disgust, when the information is received that the order has been placed at some 10, 15 or 20 per cent. lower. "How can they do it?" is the question asked. Possibly the order may be received and competitors are left wondering with the same question in their minds.

Some time ago, in the leading article of a trade paper, it was mentioned that after discussion of the importance of systematic costing with several foundry owners and a few engineers' buyers, the former in substance say that they know their costs to within reasonable limits, but the engineers' buyers will not pay a remunerative price. The latter assert that the variation in quotations received from the various foundries is so great that as business men they are forced to rule out those falling into the higher-priced category. The cause of this considerable variation in prices quoted by founders, they continue, must be attributable to either one or both of the following causes:—

(1) Inefficient and incomplete costing; and (2) large differences in the general expenses of the businesses.

A prominent foundryman, writing to this paper in connection with these assertions, pointed out that some founders admittedly guessed prices outright, whilst others make a fairly honest attempt to calculate the average cost of castings falling within weight ranges and then quote prices within these ranges, irrespective of the individual difference between one casting and another, and some go to the trouble and expense of working out a specific estimate of the cost of metal, labour and oncosts. Concluding his letter, he said that the buyer will always be free to exploit the unavoidable difference between the costing methods and the production facilities of various competing tenderers and may be relied upon to do so. "There is, however," he said, "no good reason why any founder should extend to any buyer the grotesque advantage of purchasing from him at a figure well below cost."

It may be taken for granted the unanimous opinion of thinking foundrymen is that for true progress of the foundry industry guessing at costs should be eliminated and that costs should be prepared on a true basis

The costing systems of some firms are the most dangerous part of the organisation, because such systems give information which is not correct, and information which is not correct is of very little use in any business. For the low prices being paid to-day one can only blame the foundryman; whilst the buyer knows that he can put one foundry against another in the matter of price, he will continue to do so.

The value of correct costs cannot be overestimated. By *correct costs* one does not mean *average costs* over a year. This is not a safe figure on which to base a selling price. In a jobbing foundry the cost of no two customers' work is the same, the cost of no two patterns is the same, orders vary, conditions vary, and the cost of production varies with the conditions. Job or unit costs are the only satisfactory basis for future selling prices, and these play a very important part in the final average cost. It does not take many losses to reduce the profit and increase the average cost.

One often hears the words, "What is lost on the swings is gained on the roundabouts," and it is not unusual to hear of a foundry where orders are accepted and work done without knowledge of costs, incurring heavy losses on certain classes of work and making such profit as they can on the others. Such a condition is unhealthy. There is no guarantee that the profits will balance the losses.

When selling the product of the foundry, the owner wants to know the truth, he wants to ascertain at what price he can produce, at what price he can sell and the danger line below which he should not sell.

The Average Foundry

The average foundry may be considered as consisting of a building which may be the property of the founder, or may be rented; it has been equipped with a cupola, possibly moulding and core machines, sand-mixing plant, drying ovens, moulding boxes, cranes and tackle, benches and other fixtures. All this represents invested capital, and the owner or owners must have had in mind that capital invested in this way would give them a greater interest yield than other forms of investment, and they are entitled to such interest on the outlay.

To make the foundry a going concern, considerable expenditure must be made for the purchase of the usual supplies:—Sand, pig, coke, sprigs, plumbago, coal dust, core compounds, miscellaneous tools, and the sundry other items as buckets and core-plates, coke for furnaces, heat, light, power.

The machines and plant require constant attention, electrical fittings must be renewed, patterns which are the property of the foundry require repair, buildings have a habit of requiring continual attention, demands are received for payment of rent, rates, taxes, insurance, and as neither machinery, plant or buildings last for ever, a fixed amount must be reserved for depreciation and the replacement in due time.

Labour must be paid, National Health and Unemployment Insurance must be met, and the cost of supervision and office staff all go to increase the cost of running the shop.

Very briefly, these are some of the details confronting the owner, and in the interests of the industry one must consider the fundamentals of business and think over some of the details which enable men to receive wages for labour expended or interest on money invested. With this in mind the expenditure is divided under two distinct headings:—(1) The amount paid which directly increases the value of the article being made, and (2) the amount paid which does not increase the value of that article but which increases the cost.

The first item is *direct* or *productive* expenditure and the second *indirect* or *non-productive* expenditure.

Strictly speaking, the only foundry material item which can be called productive is the metal. It may, of course, be argued that other items contribute to the finished casting, but what is sold is the metal only.

Labour enters into the cost of a casting in two ways, directly and indirectly, the former being that which actually produces the saleable casting. Only the moulding and core-making labour are strictly direct or productive—they produce the casting. It is, however, generally accepted that fettling labour is treated as a direct charge because such labour can generally be charged directly to the cost of the saleable casting.

The word "expense" in a foundry must be used broadly because it covers every item of expenditure other than the four items, metal, moulding, core-making and fettling, which has been indicated as *productive*.

It is not practicable in the foundry to charge items of expense to the finished casting; all such items must find their way to the cost of the casting through overhead charges, or, as is more popularly known, "oncosts." Therefore, all forms of expense should be classified, and for various reasons the author classifies them as:—(1) Fluctuating, and (2) fixed.

Fluctuation Expenses

Fluctuating expenses are those which are controlled by production, and fixed expenses those which must be paid whether the foundry is or is not producing, and generally it can be said that fluctuating expenses include:—

Non-productive Labour of the Shop.—Shop labourers, crane drivers, maintenance staff, storekeepers, lorry drivers, etc.

Consumable Stores.—Moulding and core sands, oils, compounds, chaplets, bore irons, and all those items which are a direct charge against production.

Tools.—Spades, shovels, brushes, chisels, bellows, grinding wheels, etc.

Shop Expenses.—Gas, water, power, light, pattern repairs, National Health and Unemployment Insurance contributions, maintenance of machinery and plant, etc.

Fixed Expenses

These include rates, taxes, insurance, management, and clerical staff, office expenses, publicity, bad debts, depreciation of machinery and plant, repairs and maintenance of buildings.

Main Items

There are thus the three main items of cost:—(1) Metal; (2) productive labour; and (3) expenses (*a*) fluctuating and (*b*) fixed.

Most foundries take care to see that the amount paid in wages for moulding, coremaking and dressing is carefully recorded by the usual methods, but it is suggested that, whilst care is taken correctly to record the amount, no record is kept of the hours worked, and this is most important, as will be proved later.

The recovery of expenses is attempted by varying methods, and very often the use of one particular method can in part be justified by the person using it. Some say that to take the percentage of the total expenses to the total productive wages for a given period will give an oncost figure which should prove reasonably accurate over a further period, others say that the expenses should be recovered by a fixed charge per ton; whilst others say that a percentage on moulding and coremaking wages, and a charge per ton for fettling, is more accurate.

All three methods are in use and are quite good methods, providing that all men are paid the same wages and all produce at the same rate, and all castings are in one class and do not vary in weight or design.

It is suggested, however, that the most satisfactory method of recovering expenses fairly is, as far as possible, to make each department bear its proper share of expenses. If one can bring oneself to imagine every department of the foundry being entirely independent, for which one engages labour, pays expenses, etc., then there is a basis on which the foundry can recover, through the selling price, the total cost of production.

Overheads related to Productive Hours

As a result of several years' experience, the author is of the opinion that to calculate overheads by the productive hour method is most correct and reliable. Whether the moulder be a

skilled man in a particular type of casting, an inexperienced man who must feel his way, an improver or an apprentice, it is improbable that the amount paid in wages will determine the expenses incurred, and to add to the wages paid a fixed percentage to cover expenses is an unfair method.

Assume three jobs, each with a different type of labour, experienced at 1s. 6d. per hr., inexperienced at 1s. 3d. per hr. and apprentice or improver at 9d. per hr., and use the percentage method of, say, 100 per cent., the cost per hour will be 3s., 2s. 6d. and 1s. 6d., thus allowing for the first man 1s. 6d., the second 1s. 3d. and the boy 9d., to cover all the expenses incurred.

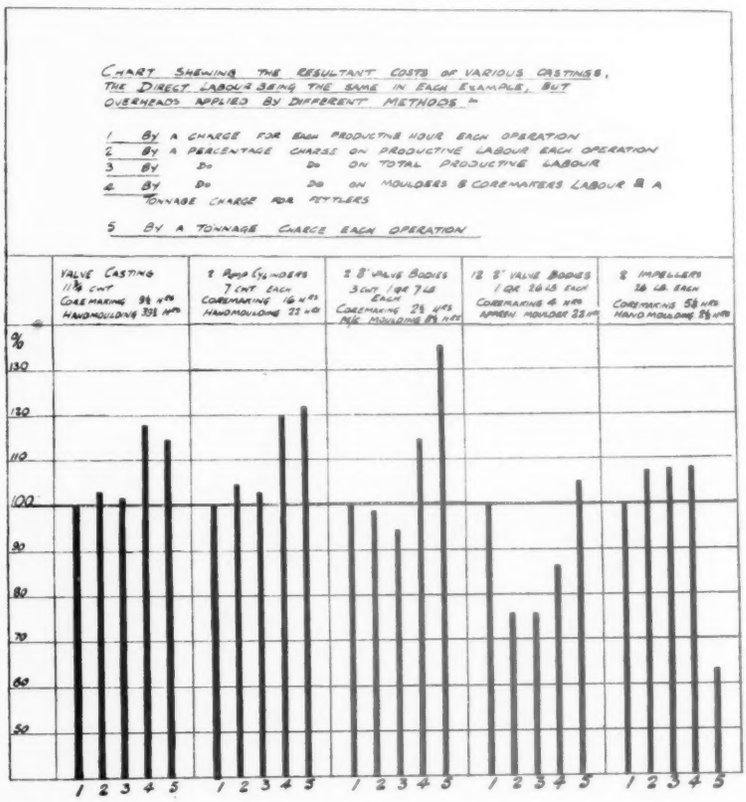
CHART SHEWING THE RESULTANT COSTS OF VARIOUS CASTINGS, THE DIRECT LABOUR BEING THE SAME IN EACH EXAMPLE, BUT OVERHEADS APPLIED BY DIFFERENT METHODS
1 By A CHARGE FOR EACH PRODUCTIVE HOUR EACH OPERATION
2 By A PERCENTAGE CHARGE ON PRODUCTIVE LABOUR EACH OPERATION
3 By Do Do ON TOTAL PRODUCTIVE LABOUR
4 By Do Do ON MOULDERS & COREMAKERS LABOUR & A TONNAGE CHARGE FOR FETTLERS
5 BY A TONNAGE CHARGE EACH OPERATION
VALVE CASTING 11¾ CWT COREMAKING 9¾ HRS HANDMOULDING 33½ HRS
2 RAM CYLINDERS 7 CWT EACH COREMAKING 16 HRS HANDMOULDING 22 HRS
2 8" VALVE BODIES 3 CWT 1 QR 7 LB EACH COREMAKING 24 HRS MACHINE MOULDING 8½ HRS
12 8" VALVE BODIES 1 QR 26 LB EACH COREMAKING 4 HRS MACHINE MOULDER 2¾ HRS
2 IMPELLERS 26 LB. EACH COREMAKING 5¾ HRS HAND MOULDING 8½ HRS
%
130
120
110
100
90
80
70
60
50
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5

FIG. 1.—INFLUENCE OF METHOD OF ASCERTAINING OVERHEAD ON PRODUCTION COSTS OF VARIOUS TYPES OF CASTINGS.

It would be natural to assume that the order should be reversed.

The percentage method on wages provides only for a distribution of expenses according to the wages paid, whether such wages be high or low, and does not correctly account for the expenditure which is being incurred for the period he is working.

It may be said that the wages are known, and it is much easier to distribute the charges on wages, but whilst the wages are known, the hours can be known also. Is there any item of expense which would increase because a man's wages are high or low? An analysis of wages paid is essential, and this analysis can easily include the hours worked.

The charging of materials used and the labour expended to each section of the foundry is not a very difficult matter, and the totals of all expenses divided by the production hours of all producers gives the amount expended per hour.

A Typical Case

The illustration (Fig. 1) of the cost of five distinct types of castings will serve to show the effect on the final cost by five different methods of applying overhead charges. All five methods are obtained from the same series of figures, taken over the same period, and over the period the figures used represent the correct overhead charges by the different methods for the total output.

The examples are costs of steel castings, and the various processes of a steel foundry are coremaking, sand moulding, machine moulding, closing, sandblasting, fettling, grinding, sawing, cutting and machining, the last process covers only for the removal of heads. The results shown prove conclusively that all five methods of applying overhead charges cannot be correct for individual castings.

It is not the object of this Paper to detail a costing system, but only to describe the fundamentals of a good system, principles which may be adopted in the devising of a system or in the revision of present systems which may not be quite satisfactory, so itemised details of the various methods of obtaining figures are omitted.

Ascertaining Metal Costs

Much has been said from time to time on the question of metal cost and how it should be charged:—(1) To take the average cost of metal in finished castings over a period and use that figure for all types of castings; and (2) to weigh the headers removed, thus charging the casting for the full weight poured and giving credit for the value of returns to furnace.

In steel-foundry practice where headers are large, it is essential that the weight as-cast should be known; in a general iron foundry it is not as essential. Whether steel, iron or non-ferrous metals are melted, the cost of the metal should include all items of expense incurred by the melting department.

The cost of domestic scrap is a point on which opinions differ, but a reasonable attitude is to charge the price at which an equivalent type of scrap can be bought. Circumstances will determine whether the scrap is of high or low value, for example, the scrap from manholes could not be classed with textile and cylinder scrap. When iron is mixed to analysis, his own scrap is of a much higher value to the founder than any scrap which could be bought, and the value would be calculated according to the proportion which would be charged in the metal mixture. It is important to bear in mind that whatever may be the yield of good castings, the cost of melting is the same.

A Practical Example

	£	s.	d.
Assume that 100 tons of metal has been charged at a cost of	400	0	0
After allowing the usual 5 per cent. melting loss, the weight of metal available for castings would be 95 tons for a cost of..	400	0	0
Total inclusive cost of melting is	57	0	0
Thus making the cost of 95 tons of metal	457	0	0

or £4 4s. per ton for metal,
and 12s. per ton for melting.
So that the cost of the metal in the ladle is £4 16s. per ton.

Assume that a casting of 15 cwts. needs 20 cwts. metal:

	£	s.	d.
The metal cost is	4	4	0
5 cwts. is returned to scrap at a scrap value of, say	0	15	0
	3	9	0
The cost of melting that 15 cwts. is ..	0	12	0
	4	1	0

and the cost of the metal in that casting is £4 1s. for 15 cwts. = to £5 8s. per ton.

Irrespective of the yield of good castings, the melting cost should always be calculated on the weight that is poured. The melting cost is the same whether the yield is 50 or 75 per cent.

Consider the value of runners, risers, etc., whilst these when cold are worth only scrap value. The same metal in castings has a saleable value, and the cost of metal in the ladle may be 4s. 3d. per cwt., when cold it may be worth only 75 per cent. of that value; therefore, the higher the percentage of risers, etc., the higher the cost of metal in castings. Very often there is a tendency to look at risers as so much scrap, and not so much wasted casting metal.

The amount of coke used reflects itself in the cost of metal and becomes quite an important factor, proving that cheap, inferior coke becomes very costly in the long run.

Piecework and Day-Work

When authorities speak of piecework they mean payment for what is produced, such payment being above the normal wage which would be paid for a similar working period on day work. By this method the worker has an incentive to increase his production. The employer pays a higher wage but receives in return a higher production per hour, which reduces overhead charges, both fluctuating and fixed. Thus, if a moulder produces at the rate of 1 cwt. per hr. on plain time, and increases this production to 1½ cwts. per hr. on piecework, he receives the equivalent of 50 per cent. gain in his wages, and the employer in return, who may have a fixed charge of 2s. 6d. per hr. for overheads, finds the cost reduced from 2s. 6d. per cwt. to 1s. 8d. per cwt., and the wages per cwt. correspondingly reduced.

Piecework on repetition jobs is an ideal system of payment, but in a jobbing foundry, where different jobs are undertaken, it does not prove as beneficial as day work. This, however, is a matter for individual consideration, and it is only mentioned as a point of interest.

(To be concluded.)

THE MANY FRIENDS of Dr. Guido Vanzetti will be interested in the announcement that his sister, Signorina Ida Vanzetti, was married on April 28, at Milan, to Signor Lino Salghetti-Drioli, of Florence.

THE FIRST NEW BLAST FURNACE at the Corby works, near Kettering, of Stewarts and Lloyds, Limited, was lighted on Tuesday by Miss Elspeth MacDiarmid, in the presence of the directors, the engineers (H. A. Brassert & Company) and others.

The Steel Castings Report

DISCUSSION IN GLASGOW

(*Concluded from page 289.*)

Need for Research at Elevated Temperature

DR. J. W. DONALDSON said that after reading the Report he realised how much he was out of touch with the steel-casting side of the foundry industry. He did not feel he was in a position to criticise the Report from the steelfounder's aspect, as he was more inclined to consider castings from the engineer's point of view. Engineers considered that there was much to be desired of steel castings, and he was glad that Dr. Greaves had stressed the fact that this Report did not deal with the manufacture of steel castings and defective castings in general, but was a Report dealing with some of the defects, which occurred in steel castings, which had to be considered as a preliminary to further work.

Dr. Greaves had stated that work was now in progress dealing with the physical properties of steel, at or near its melting point, and he agreed that this work was of importance. The extension of such work to mould materials, moulding and core sands, was also necessary, and had been referred to, and in this Report, and as a member of the Technical Council of the Institute of British Foundrymen, he could support what Mr. Campion had said regarding the work of the Sand Sub-Committee. In his opinion, an accurate knowledge of all data relating to steel and sand was necessary in dealing with all steel-casting problems.

A Compositional Specification

MR. SHARPE said that he regretted the absence of representatives of some of the larger steel foundries in the West of Scotland, and he could only assume that the technical staff had absented themselves because of the extremely difficult position in which the active steelfounder was placed in replying to the Report. He thought it was unfortunate that at this early stage in the investigations into the manufacture of steel castings, such an extremely difficult specimen had been selected for submission to the super-examination and testing outlined in the Report. He was of the opinion that, had the steelfounders been unaware of the very minute examination that these castings were to undergo, there would have been very much less variety in the methods recommended for their manufacture. He was confident that in two or three local steel foundries specialising in high-pressure valve work and producing these from steel made from open-hearth acid furnaces, castings would have been produced which would have stood up to the normal inspection, physical and pressure test called for under ordinary circumstances. He would have selected a steel with a carbon of 0.3 to 0.35 with the silicon of manganese suitably balanced to give a steel, which, when well annealed, would show a tensile of 30 to 33 tons per square inch and a bend test of at least 90 degrees.

Super-criticism by the Committee was the reason for the manufacture of these particular castings, and the result of this super-criticism has already shown how valuable it will be when applied to more normal designs, and he was confident that further work by this Committee, in conjunction with steelfounders, would have a very beneficial effect on the future of steel castings. It would bring forward to the engineer and designer the great importance of design in relation to change of section and abrupt interference with the contraction of the steel casting in course of cooling from the liquid to the solid. It had to be admitted that the design before the Committee was, should he say, a draughtsman's nightmare, and a warning to all good draughtsmen to keep clear of any such atrocities in future designs.

Mould Expansion

He wanted to bring out one point on which he thought insufficient attention was paid. This was with regard to the expansion of sand in the mould after pouring. It must be realised that in this particular test casting, there would be at least ½ in. of contraction between the overall flanges. This contraction was really taking place because of the heat passing from the metal to the sand, and, although we could definitely measure the contraction on the casting, we could not measure the amount of expansion to which the sand mould was subjected while the heat was passing into it. From independent investigation it was clear that severe stresses were set up in the mould in immediate touch with the casting because of the sand expanding while the semi-liquid casting is contracting. This point should have very careful consideration by the Committee in future discussions and examinations.

During the past few years, he had been in touch with a considerable amount of work being done to endeavour to overcome this expansion of sand. One method which has proved valuable where it is practical to employ it is the feeding of water, immediately after the steel has set, to recesses made in the mould prior to casting. If blocks of wood are carefully embedded in moulding sand at points where contraction is likely to cause tears and if immediately the steel solidifies, the blocks are removed and water is poured into the holes, at the temperature of the sand the water soon boils and destroys the bond in the sand and allows of the sand breaking up in the mould very much quicker than any other application that the speaker had seen. It would be obvious that this process is dangerous where there is any fear of the water getting access to the castings, and considerable foresight and thought should be applied to its application. For instance, he would not suggest its use in a case like the valve body in the Report, and would be more inclined to depend on inserting weak sand between the flanges.

Disposition of Runners

Many years ago he worked with a very capable but illiterate foundryman, who told him that when he experienced trouble with steel castings tearing or being blown, he always shifted his runner as near to the trouble as he could get it. This advice had frequently been made use of over a period of 25 years, and his experience was that, by getting the metal run as close as possible to a tear or a blow, it appeared to shift the trouble out of the mould or possibly to some other less important part. It might be coincident that this happened, but it would be worth while young steel foundrymen keeping this advice in mind. There was good sound reason for having the metal run through a part which was likely to cause trouble, and this running of the metal through the part was possibly the real reason for overcoming the difficulty. He advocated the getting of the metal into the mould quickly. He had some experience of what they called "dripping heads." Where castings had caused difficulty from dirt and in some cases from tearing at extreme ends, he applied the method of allowing a higher gate than head box and passing a large quantity of metal through the mould and taking it away in a basin so that the original metal which was run into the mould was actually forced out by clean hot metal following in its wake. This, of course, could not be looked upon as a commercial proposition, and could only be applied in extremely difficult cases. The same practice is commonly carried out in iron foundries where ornamental and highly-relieved work calls for perfectly clean metal.

Application of Tarred Sand

With regard to the application of tarred sand, he had seen this used very extensively. In his early training complete moulds of stern posts, double propeller brackets and other very large castings were rammed up in a composite sand made of ground firebrick, silica sand and bonded with pitch or tar. The mould was thoroughly dried and a large percentage of the volatile material was driven off, but when the metal was poured in the mould explosions took place, because of the enormous pressure from the tar gases produced. When the mould was well vented, these gases passing through the sand at the very high temperature at which they were generated, apparently had the effect of destroying the bond, so completely that it withered and allowed the contraction to take place with surprising rapidity. At the present day, this old method of using tarred sand is looked upon with ridicule, but one might find in its application useful information regarding the withering of moulding sand under temperature. He had seen tarred sand used in corners of ordinary sand moulds with very good result. The tarred sand was applied at a point at which contraction might be expected to take place, and the temperature of the metal seemed to destroy the sand and allow the casting to contract. It might appear out of place in a serious discussion such as the present to make reference to those small tricks of the trade as applied by the older foundrymen, but he was confident that on investigation many of these so-called tricks would be found to be based on very sound metallurgical application and that they were certainly worthy of careful examination.

In the manufacture of steel castings, moulding sands were almost entirely synthetic, and a great deal of work had still to be done in producing the best medium in which to pour steel castings. He would like to see a moulding sand produced which would allow of the quicker pouring of the mould. Pouring the metal into the mould as quickly as possible will overcome many of the present difficulties.

A Bad Advertisement

MR. JOHN CURRIE (President, Scottish Branch, Institute of British Foundrymen) said, as a steel foundryman, he was not so optimistic, and, in fact, he was rather disappointed, firstly, as the Report was a bad advertisement for steel castings, and, secondly, because of the fact that the Committee had allowed too many variables to enter into their investigations. Here they had a casting of bracket type which they were told had been cast by nine different firms, with nine different types of metal, with probably nine different moulding and core sands, different runners cast into positions, and different feeding heads, any one of which he contended was capable of introducing troubles which would lead to rejection, so that in connection with the further work of this Committee he would suggest that they confine themselves in the first instance to the original aim, that was, to collect reliable data of the occurrence, cause of formation, and prevention of blow-holes, cracks, porosity and non-metallic inclusions, and then when they had some reliable data in connection with these matters, they would be in a much better position to produce a sound and economical casting. To discuss the various castings

described in the Report was impossible, but, to his mind, some of the castings and the methods of production were doomed to failure before they were cast, especially the one described and shown on the screen, where he imagined that the feeding heads were totally inadequate to feed the casting. The Committee, however, had to be complimented on the enormous amount of work that they had done and the investigations they had carried out, and although the Report might seem unsatisfactory, it only went to show how wide was the problem and the many difficulties encountered. To the uninitiated perhaps this Report tended to show that the production of a commercially sound casting was well nigh impossible. He hoped that this was not the case. It also indicated another very important point that in a particular casting of this type a yield of only 50 to 60 per cent. of the metal was all that could be expected, so that for castings such as this, or castings of similar test, the price must be much higher than for castings not subjected to such high examination and test. This was a point that buyers might bear in mind. In conclusion, he might say that, whilst he was not altogether satisfied with the Report, he was very pleased that something was being done to combat the difficulties encountered in the steel foundry, and if in the near future the Committee could let them have information and reliable data bearing on this subject, that he believed would go a long way towards helping the foundryman in his every-day troubles.

Teeming Speeds

MR. KIRBY said that the question of design had been referred to. Whilst the design of a casting was very often faulty, they must admit that even in instances where the section was very uniform a guarantee of absolute soundness could very rarely be given where walls were at right-angles, unless some form of chilling was adopted. The necessity of chilling and the running of a casting were the main points, and he did not agree with Mr. Sharpe or with Mr. Campion that they should fill the mould as quickly as possible; in fact, his experience had been practically the opposite. The table on page 17 of the Report bore out his contention that chilling at the conjunction was essential. In the case of the first rejected cylinder, a slewing cylinder, which failed under water pressure at 3,000 lbs., referred to on page 18, this would suggest that an increase in the manganese content would most probably have given better results.

Chilling Methods

Mr. MacConnachie mentioned high manganese and high carbon, and in this particular instance of the cylinder referred to the manganese content was only 0.58 per cent. Personally, he never expected a casting such as this with only 0.58 per cent. manganese to give a good result. He agreed that the chilling as shown on page 22 was beneficial, but thought that better results would have been obtained if the chills had been tapered from 2 in. to ½ in. thick instead of 2 in. thick throughout and 2 in. wide. One often heard adverse remarks about steel castings, but, *inter alia*, in this Report there appeared to be some justification for the adverse criticism levelled at the unfortunate foundryman. In the making of these castings, in only two instances had these been cast vertical, and the results obtained compared favourably with any of those cast in a horizontal position. He believed that to cast vertically was the best method, but he also believed that the job should be run from the top with a series of little inlet gates. He remembered some years ago employing this method himself with very beneficial results. By running in this manner instead of from the bottom as shown on Fig. 50, or with inlets as shown on Fig. 49, coupled with the judicial application of external chills, he thought that better results would have been obtained. Mr. MacConnachie mentioned also about trying to chill moulds with tar-sand, but, personally, he could not see how they could get a good chilled result from that. Mr. Sharpe mentioned the expansion of the sand, and he quite agreed with him that sand was a very important factor.

Mould Filling Methods

The CHAIRMAN, speaking in connection with the production of these castings, said different people advocated different methods of pouring the metal into the mould. That took his memory back to the time when they had castings weighing anything from 8½ tons to 13 tons, and they would have finished 45 to 48 feet square, of perfect surface, which were machined, planed, and had to be a perfect fine-quality casting; there was considerable trouble in getting these things. He followed up the technique of moulding and casting, and it came to this, that the metal was led in at one end of a horizontal mould, poured from two big ladles, and it was found that there was a certain sort of rebound from the end of the mould when done that way the first time, so there were holes put through the end of the mould leading to an external pool or head, and the virtue of that was to allow the first metal to clean and heat the mould and to avoid the wave which previously rebounded and formed "lap." He thought this was a question as to whether the various ways of pouring had been quite clearly described in some cases during the discussion, or whether the pouring should be such as somebody indicated, that was to pour more metal. Did they want that metal to go through the casting, or did they want it to go down and flow over on the top? That had not been always clear, and the matter sounded so much like his own problem that he felt he must take up their time just for a moment. This was a very expensive casting, on which a great deal of money had been spent, and from which they should have reliable results.

A Satisfied User

MR. BRIDGE said the first impression he got on reading the Report was similar to that of some of the other speakers, namely, that it seemed almost impossible to get a steel casting free from some defect or other; and the second point that occurred to him was that no distinction had been suggested as between the quality of steel castings that were required for a purely mechanical function, such as the joining together of structural members under stress, and the quality of castings that were needed mainly to withstand high internal pressures and in some cases very high temperatures as well. It was rather a pity, he thought, that the Report did not embody those concluding remarks of Dr. Greaves about the Committee's functions as regards dealing with certain specific defects, and thus remove the somewhat false impression as to the great difficulty of getting good castings. He had had experience of castings of both those types he had mentioned, and there had really been no trouble with them at all in service. If one went to a reputable firm he thought that one could get reasonably sound steel castings for any purpose specified. Several references had been made to the rate of pouring the metal into the mould, but it seemed to him, though here he spoke with special diffidence, that the best rate of pouring must depend very largely on the size and shape and inclination of the mould being filled, and that what was required was to fill it in each particular case as quickly as possible without permitting the inclusion of gases. Another point which he had always understood as rather important, though seemingly not referred to in the Report, was the advisability of releasing the mould from the casting as soon as ever the metal had set. With regard to the class of castings he had referred to as needed for high internal pressures and temperatures, a few years ago a little trouble had arisen with distortion of valve seats in power-station work due to increasing steam temperatures, but valve makers have since got wise to the requirements and have produced improved designs, as a consequence of which they had no trouble now with such distortion. Although steam temperatures are still going up, the steel castings were proving perfectly satisfactory. The absence of porosity, of course, is of very great importance in such cases, and in regard to this there are no references in the Report to hydrostatic testing with anything else but water. He was not sure whether it was generally appreciated that porosity could be very much more readily detected by using a light oil instead of water. He believed that kerosene was used for the purpose, and he was rather surprised that there was no mention of this point in the Report.

No Difficulties Experienced

MR. SEMPLE said the class of steel castings that he was accustomed to handle were used for mechanical purposes only, and he had not found any great difficulty in getting satisfactory steel castings. He was rather surprised to hear that there were so many flaws in a casting of apparently good quality which were not visible on the outside, and he was wondering whether the castings they had been satisfied with for quite a number of years were full of those flaws and cracks and hidden defects. Certainly they had not been serious enough to lead to any failure in service.

Tests on Mould Expansion

MR. F. HUDSON said the steelfounder should be grateful to the Steel Castings Research Committee for the unbiased way in which this Report has been presented. Admittedly most attention has been focussed upon the foundryman and the type of casting he should not produce. At the same time such information would let the engineer and purchaser have a better appreciation of the numerous difficulties which arise in the production of serviceable castings and the need for very close co-operation in design and economic problems.

Many of the designs produced to-day in cast steel have altered in no great degree from the essential features of their prototypes of the cast-iron era and perhaps steel, in its cast form, had suffered because of this inheritance. Furthermore, it would appear that there is a tendency among foundrymen to devote their energies to the production of these designs as submitted, without bringing to the attention of the engineers the features which impose high production costs. The Report fully accentuates the need of whole-hearted co-operation in this direction. At the same time, personally, he considered much of the initiative in bringing about such co-operation should belong to the designing engineer.

One could not too strongly stress the fact that the difficulties occurring in the production of serviceable steel castings did not lie in securing the mechanical properties demanded, but in ensuring freedom from cavities and other discontinuities. In connection with this point, and having particular reference to those factors affecting the formation of "hot tears or pulls," etc., caused by contraction stresses and mould or core resistance, it was important that greater attention be paid to foundry sands. It was not generally appreciated that when a mould was cast the sand actually begins to expand, whilst the casting contracts. Consequently it was not surprising that "hot tears" are frequent and their prevention calls for the placing of brackets. Actual expansion tests conducted on ironfoundry sands have shown results of ¼ in. per ft. on heating to 1,000 deg. C., and he quite confidently anticipated that similar results would be found for those sands used in the founding of steel castings.

It was also worthy of note that this expansion of the sand varies according to the particular mixture used and could be markedly reduced by certain modifications to that mixture. Research in this direction might result in the production of more suitable sand and core mixtures for steelfoundry service and lead to the safer production of castings.

Pouring Temperatures

MR. T. M. RITCHIE said the question of the temperature at which the metal was poured was an important consideration and one to which greater attention might have been directed. For the relatively thin sections of the given castings a considerable superheat was required and this resulted in the solution of the gases in the metal. When the metal cooled these assumed again their gaseous form, which may account for the porosity indicated in certain of the sections. There was a strong relation between any given casting and the temperature at which the metal should be poured, and this very important factor was generally left to the skill and experience of the moulder.

Great stress had rightly been placed on the moulding sand by various speakers. Care was usually taken to screen the facing sand to some particular mesh, but, in doing so obviously a considerable quantity of smaller sand and dust passes through.

When the molten metal came in contact with this dust, the dust was fused into silica and so closed up the pores of the mould and prevented the escape of the gases through the sand. The result might be blow-holes near the skin of the casting.

In certain American foundries great attention was given to this question of sand, and not only did they screen it to keep back grains over a certain size, but grains under this size were also removed.

The Report indicated that a large number of methods were employed in moulding the castings, while the net results were not widely different. Defects found in one casting might just as readily have been found in any other. The method of moulding had an important bearing on the cost. While this aspect might be outside the scope of the Report it is of vital importance to users who invariably purchase in the cheapest market and unhesitatingly reject castings which are defective without reference to how they were made.

Slow Teeming Advocated

MR. WM. HAMILTON said that as a maker of one of those discredited castings, he disagreed with some of the remarks of previous speakers in as much as they wanted them to fill the mould as quickly as possible and to run so much surplus metal through the mould. He thought that by doing this they were defeating their own object, and he maintained that such action was quite wrong, and that the best way to make these castings was to pour sufficient metal into the mould and then travel to the feeding head, keeping the feeding head as hot as possible in order to prevent any segregation, as by doing this they would not disturb the inner part of the mould. Mention was made of the use of pitch or tar, but that was in the Dark Ages, for the simple reason that pitch or tar, if used, created a gas which was definitely against the production of a good sound steel casting.

The CHAIRMAN said that with regard to the question of the mould and the expansion of sand, because of the steel expanding they got into the region of the transformation of silica, and the silica (quartz or sand) would be transformed into tridymite and/or crystobolite when both of those were lighter and larger in volume than the sand in which they would rise. It seemed to him that the thin section of sand next the casting was about as far as that action could be expected to penetrate, and as he sat listening to the discussion he had been trying to picture in his own mind how it was possible, if at all, for a relatively thin section of sand, which was being transformed into one of those other forms of silica, to exert any effect against the mechanical properties of such a powerful thing as a steel casting, and he was going to ask Dr. Greaves if anything had been done to elucidate the point as to whether the sand expanded in the mould, because silica did not really expand very much.

AUTHOR'S REPLY

DR. R. H. GREAVES said that if he attempted to reply in detail to the many points that had been raised it would take him a considerable time, so, if they did not mind, he would depart from the order of the speakers and just try to give a few replies which covered a number of the questions raised. He should like first to thank Mr. Currie for his remarks, and give one or two explanations in regard thereto. Mr. Currie said, quite correctly, that there were too many variables in their experiments, but actually there were not quite as many as they had been led to suppose. For example, he himself had mentioned that they had obtained the expert opinion of nine works, but that did not mean that all these nine works made the castings. Actually 16 castings were made in seven different works, five making two each and the other two three each. In each works they aimed at one variable only, to get comparison between the two or three castings made there, but in considering all the results other variables were introduced because, for example, they could not get temperatures the same in all works. They would see from Tables V and VI what had been done. The Committee knew that some of the castings made were doomed to failure, in fact, the expert opinions to some extent cancelled one another, but they thought it would be desirable to see what happened. An important point was that the trial castings were all made at about the same time and without previous experience of how the other castings had turned out. He had no doubt that all these works, had they been given a second opportunity, would have made good castings. It, therefore, had to be borne in mind that these castings were all independent first efforts.

The Object Sought

The question had been put by Mr. Bridge as to whether it was possible to get an absolutely sound casting free from defects. His own view was that for practical purposes they must aim at getting a casting sufficiently free from defects, and with the defects where they did not matter. To get a perfectly sound ingot was difficult; but, bearing in mind that a casting really consisted of a number of different, irregular, ingots all joined together, but all requiring adequate feeding, it was clear that the problem of getting an absolutely sound casting was almost insuperable. That, however, did not affect the fact that they could get castings which were perfectly good for the purpose for which they were required. That led him to another point. Mechanical tests had been mentioned, but it did not follow that a casting was better because cast-on test-pieces showed exceptionally high mechanical properties. The casting might have other defects which nullified its having a better mechanical test, so that the demand for high mechanical test might be putting the emphasis on one of the less important features of the casting. It had been most interesting to hear the remarks of Mr. Hamilton and Mr. Kirby, whose experience differed in some respects from that of the other speakers. He must not tell them which of the castings was made by Mr. Hamilton. The remark had been made that Scottish castings would have gone through at the first time. There were Scottish castings among them, and he could at least say that they were not the worst. Mr. MacConnachie made a valuable contribution to the discussion.

I.B.F. Committee's Work

Although the Tropenas method of manufacture was not referred to in the Report, he understood that the Institute of British Foundrymen had in hand quite an extensive research on the methods of steelmaking as applied to steel castings. Mr. MacConnachie referred to Casting No. 7, in which the elongation was the same before and after annealing. That was so, but there was a very great difference in its fineness, in structure, and its toughness after annealing. That was shown by the impact value, which was five to six times as great after annealing as in a cast condition. They could get materials which were brittle, and yet gave good elongation in the tensile test. Mr. Campion's remarks were also very interesting. He indicated that the Committee ought to get into touch with the Institute of British Foundrymen. It was hoped that in the near future they would be able to talk over together the respective programmes that were being followed and so co-ordinate some of the work they were presently doing. With regard to the physical properties of the liquid steel and the changes it underwent in solidification and subsequent cooling, contraction was always one of the great difficulties, and therefore all those methods, which have been called "tricks of the foundry trade," to avoid the bad effects of contraction by loosening and by breaking up the sand, or by weakening the sand in some other way, were of the greatest importance, and were probably the only way in which the action of contraction could be overcome.

Composition and Contraction

The influence of composition on contraction was very small, and they could not wholly eliminate it by variations in composition, but could only deal with it by some mechanical method. That brought him to the remarks of Dr. Donaldson on the matter of work on the physical properties of liquid steel and of steel during and after solidification. That was a question which was engaging the attention of the Research Committee at present. For example, the effect of the fluidity of steel was bound up with, but was a much wider subject than, that of the casting temperature. The mechanical properties of the steel immediately after solidification were also of great importance. Steel that solidified in the mould had a low strength, with practically no ductility, and therefore the smallest strain put on it raised the tensile stress of the steel up to the breaking point. That occurred in the mould until a temperature of about 1,300 deg. C. was reached. These and other subjects urgently required investigation. He did not think that he could usefully say anything more. He was, however, sure that the Committee would be very pleased with the way in which this discussion had gone. They would derive great benefit from the suggestions that had been made by the different speakers, and would take fully into account the experience which had been put at their disposal that evening.

A vote of thanks, proposed by Mr. George Ness, concluded the proceedings.

Iron-Silicon Alloys

According to a Paper on "Diffusions that take place in Iron-Silicon Alloys during Heat-Treatment," read before the American Institute of Mining and Metallurgical Engineers by MR. N. A. ZIEGLER, unalloyed iron, when subjected to an oxidising heat-treatment, takes on an iron-oxide scale on the surface. If heated further, this scale gives up its oxygen, which diffuses into and saturates the pure iron. However, in an iron containing a minimum of 2 per cent. of silicon, a film of iron silicate forms on the surface and acts as a barrier or filter to the diffusion of the oxygen atoms into the alloys. It is also pointed out that this film does not interfere with the diffusion of carbon and therefore does not prevent decarburisation.

Petrographic Methods in Slag Examination*

By R. Graham, B.Sc., Dipl.R.T.C., and Prof. Hay, Ph.D., F.I.C.

The preparation of thin sections of slags for examination by transmitted light is a very difficult operation, because of the friable nature of these materials. Moreover, in many cases the sections when mounted in Canada balsam are not suitable for refractive-index determinations. Also, it was not possible in the system here dealt with to obtain massive samples of the melts on account of refractory limitations.

Examination of slag systems by reflected light had been tried, using a technique similar to that employed in metallography, but the results were not satisfactory; changes in the composition of the phases could not be detected with sufficient accuracy.

Utilisation of the optical properties of the phases appeared to offer a method of successful identification. Attempts were therefore made to obtain the material in a state of uniform thinness to permit of this. The majority of the melts were available only in the powdered form. Some of the melt was placed on a glass slip and covered with Canada balsam. After setting, the slag was ground by rubbing on a glass plate using F.F. carborundum with a mixture of 25 per cent. glycerine and 75 per cent. water as a lubricant. This procedure failed to give the desired results and was finally abandoned after trying various grades of abrasives and different lubricants.

As the material was in powder form Beck's method for the determination of the refractive index was tried. The refractive indices of the liquids employed were checked with an Abbé refractometer. Many of the crystals were sufficiently thin to permit of other optical properties being determined, as for example pleochroism, isotropic or anisotropic state, and the angle of extinction if anisotropic. The highest refractive index readily attainable in liquids is 1.74, whereas many slag constituents have refractive indices greater than this. Merwin and Larsen have described a method for measuring refractive indices between 1.98 and 2.92. They employ a mixture of sulphur and selenium, which on cooling forms a glass. The powdered material is placed on a glass slip and covered with a sulphur-selenium mixture. The slip is gently heated till the mixture melts and then a cover-slip is pressed down on the material, care being taken to avoid air bubbles. The refractive index of the various mixtures employed was checked by using a number of minerals of known refractive index.

The results for the system MnO-SiO_2 are given in Table I.

Since pleochroism depends upon the thickness of the material examined it was considered desirable to check the results recorded. For this purpose a thin section was prepared from the melt containing 30 per cent. MnO and 70 per cent. SiO_2. This showed a herring-bone structure of brown material cemented together by a colourless material of refractive index just a little lower than the Canada balsam. The brown material has a refractive index much higher than Canada balsam and was faintly pleochroic. The white material showed straight extinction and the brown material had an extinction angle of 45 deg., together with very high polarisation colours. The white material was identified as tridymite and the brown material as rhodonite.

The refractive index of 1.49 obtained for tridymite is higher than the generally accepted value of 1.477. This may be due to MnO being very slightly soluble in the tridymite. The presence of the tridymite form of SiO_2 in some of the melts is based on the following evidence:—the lathe-shaped form of many of the crystals; the straight extinction shown by these; the behaviour towards fused sodium and potassium carbonates. The melt containing 99 per cent. SiO_2 was soluble in the fused carbonates, indicating that this material was composed of tridymite. The quartz from which the sample was prepared was insoluble in the fused carbonate mixture.

Table I.—*Study of the System MnO-SiO₂.*

Melt.	Phases.	Colour.	Refractive Index.	Pleochroism.	Polarisation Colour.	Extinction Angle.
MnO. SiO_2 100% —	MnO.	Deep bright green.	2·16	—	High.	Straight.
MnO. SiO_2 95% 5%	MnO and Tephroite.	Deep bright green. Colourless.	2·15 1·78–2·00	— —	High. High.	Straight Straight.
MnO. SiO_2 82% 18%	MnO and Tephroite.	Deep bright green. Colourless.	2·16–2·14 1·78–2·00	— —	High. High.	Straight Straight.
MnO. SiO_2 70·4% 29·6%	Tephroite.	Colourless.	1·78–2·00	—	High.	Straight.
MnO SiO_2 68% 32%	Tephroite and Rhodonite.	Colourless. Brown.	1·78–2·00 1·76	— Faint.	Fairly high. Medium.	Straight 45°.
MnO. SiO_2 64% 36%	Tephroite and Rhodonite.	Colourless. Brown.	1·78–2·00 1·76	— Faint.	Fairly high. Medium.	Straight 45°.
MnO. SiO_2 60% 40%	Tephroite and Rhodonite.	Colourless. Brown.	1·78–2·00 1·76	— Faint.	Fairly high Medium.	Straight 45°.
MnO. SiO_2 57·5% 42·5%	Rhodonite and a trace of Tephroite.	Brown. Colourless.	1·76 1·78–2·00	Faint. —	Medium. Fairly high.	45°. Straight.
MnO. SiO_2 54·2% 45·8%	Rhodonite.	Brown.	1·76	Faint.	Medium.	45°
MnO. SiO_2 50% 50%	Rhodonite and Tridymite. Liquation	Brown. Colourless. effect. Bottom	1·66–1·74 1·49–1·50 of melt	Faint — all rhodonite.	Medium. Low grey.	45°. Straight
MnO. SiO_2 40% 60%	Tridymite and Rhodonite.	Colourless. Brown.	1·49–1·50 1·66–1·74	— Faint.	Low grey. Medium.	Straight 45°.
MnO. SiO_2 30% 70%	Tridymite and Rhodonite.	Colourless. Brown.	1·49–1·50 1·66–1·74	— Faint.	Low grey. Medium.	Straight. 45°.
MnO SiO_2 10% 90%	Tridymite and Rhodonite.	Colourless. Brown.	1·49–1·50 1·76	— Faint	Low grey. Medium.	Straight. 45°.
MnO. SiO_2 3% 97%	Tridymite and Rhodonite.	Colourless. Brown.	1·49–1·50 1·76	— Faint.	Low Grey. Medium.	Straight 45°.
MnO. SiO_2 1% 99%	Tridymite and Rhodonite (little).	Colourless. Brown.	1·49–1·50 1·76	— Faint.	Low grey. Medium.	Straight. 45°.

These methods have been very helpful in the elucidation of the constitution of the MnO-SiO_2 system, and have been applied with equal success to the systems FeO-MnO and FeO-MnO-SiO_2.

* From a Paper published in the Journal of the Royal Technical College.

Law and Practice Relating to Trade Marks

PROPOSED CHANGES

The Report of the Departmental Committee on the law and practice relating to trade marks, the appointment of which was announced on January 30, 1933, has been published by H.M. Stationery Office (price 1s. 6d.).

The Report is unanimous, and contains a summary of the Committee's main conclusions. The main conclusions reached by the Committee include several recommendations which, if adopted, will involve fundamental changes in the existing trade-mark law. The Committee point out that some of these changes, notably those relating to the assignment of trade marks and to the registration of users of registered trade marks, relate to matters of considerable importance and urgency to the commercial and industrial interests concerned.

Assignment of Trade Marks

Among the more important conclusions reached and recommendations made by the Committee are the following :—

That the requirement for the transfer of the goodwill of the business on the assignment of a trade mark is unduly restrictive in the circumstances of modern business and ought in the interests of trade to be done away with altogether, and that a trade mark should be validly assignable for a part only of the goods for which it is registered, provided that there does not arise by reason of such assignment or transmission a right for more than one independent proprietor to use the mark or a similar mark for the same goods or description of goods so as to be likely to deceive or cause confusion. Also, that the provisions allowing this greater freedom of assignment should be restrospective in effect.

That the trend of modern commercial development requires some relaxation of the existing restrictions on the use of registered trade marks by persons other than the proprietor, and that provision should be made for the registration under proper safeguards of persons authorised by a proprietor to use his registered trade mark.

That the existing requirement of two years' use for registration in Part B should be abolished, and that, as far as distinctiveness is concerned, it should be sufficient that a trade mark, in order to be registrable in Part B, should be capable of distinguishing the goods of the applicant either generally or in any home or export market or markets to which the registration may be limited.

That provision should be made for the extended or defensive registration of a well-known registered trade mark, consisting of an invented word or invented words, which has become identified with the proprietor to such an extent that the use of the mark by others on goods other than those for which the mark is registered would create the impression that there was a connection between those goods and the proprietor of the mark.

Trade Marks Used as Names of Articles

That, in view of the need for some protection for an advertised trade mark which has been adopted by the public as a descriptive name of the article to an extent beyond the power of the trade-mark proprietor to control, the principle of the existing common law rule, whereby a word which is or has become the name by which an article is commonly known is not protectable as a trade mark, should be modified; and that Section 6 (1) of the Trade Marks Act, 1919, should be amended so as to allow the proprietor of a word trade mark in respect of a patented article or substance to preserve his exclusive rights in the mark if, after a period of two years after the expiry of his patent, he can show that his trade mark is not the only practicable name or description of such article or substance.

That the legal rights of the proprietor of a validly-registered trade mark should be extended in certain directions and should be defined by reference to the acts which should constitute infringement, according as the mark is registered in Part A or Part B of the Register, and should, when the registration is in Part A, be deemed to be infringed by such acts whether or not the act complained of is likely to lead to the belief that there is a connection in the course of trade between the goods in relation to which the mark is used and the proprietor of the trade mark; and that in particular the proprietor should be empowered to prohibit in relation to his trade mark certain acts which might injure the reputation or impair the value of his mark.

The Committee are, however, unable to make any recommendation with regard to a proposal made to them that the proprietor of a registered trade mark should be empowered to attach to the sale of goods bearing his trade mark price-maintenance conditions which should run with the goods so as to be binding upon any retailer into whose hands the goods might come with notice of such conditions. They point out that this question of the enforcement of fixed-price conditions on the sale of trade-marked goods is only one section of the larger question of the enforcement of price and other restrictions on the re-sale of goods which raises broad considerations of policy extending beyond the proper limits of their inquiry.

Sheffield Marks

That applicants for the registration of trade marks for metal goods carrying on business in Hallamshire, or within six miles thereof, should be given an option to apply either to the Cutlers' Company or to the Registrar of Trade Marks; that where an application is made to the Cutlers' Company and is objected to by the Registrar, the applicant should have an opportunity of being heard by the Registrar; and that opposition to the registration of Sheffield marks should be prosecutable before the Registrar.

Gas World Jubilee

Our esteemed contemporary, "The Gas World," has just celebrated its jubilee by a special number containing a comprehensive review of the gas industry during the past fifty years, by eminent authorities. We are glad to add our congratulations to the numerous others received by our contemporary upon the service it has rendered to the gas industry, and upon the excellence of its Jubilee Number.

Uses of Sodium Carbonate in Foundry Practice

DISCUSSION BY SHEFFIELD METALLURGISTS

Mr. N. L. Evan's Paper which appeared in our issue of April 5, created an interesting discussion as to whether a sulphur chill was superior to a low-silicon hardness in chilled-roll practice.

The CHAIRMAN (Mr. J. E. Hurst) said that the lecture had been one of exceptional interest. Every sentence had been a statement of fact, and from the point of view of conciseness it was a long time since they had had a lecture to compare with it.

Low Sulphur or Low Silicon

MR. J. ROXBURGH said he had been very interested in the subject for a long time. The teapot ladle that Mr. Evans had showed them had helped to allay some of the suspicions that he (Mr. Roxburgh) had had in regard to the soda-ash treatment. So far as his treatment went, he invariably had a very viscous slag that took a great deal of removal. He appreciated the usefulness of a skimming device such as Mr. Evans had explained. The addition of soda-ash was generally accompanied by a lowering of the silicon content, and it appeared to him that, in some instances, the effect of soundness obtained by Mr. Evans might be attributed in some way to the lowering of the silicon content. He himself was particularly interested in chilled rolls, but was afraid he could not quite understand Mr. Evans' remarks concerning sulphur content. They in Sheffield knew that a high sulphur content in a chilled roll gave hardness, and in many applications to chilled rolls a hard face with a sulphur chill was essential, or at any rate, it gave better results than was the case with other rolls where the hardness depended on other elements. When Mr. Evans spoke of lowering the sulphur, he imagined that the sulphur would be lowered to the extent of about 0.06 per cent., and it seemed to him that the hardness obtained would be much lower. He could not quite understand how Mr. Evans was getting an extra hardness with a lower sulphur content. He wondered if Mr. Evans had taken into consideration the fact that, by reducing his sulphur to such an extent, the control of the chill would be more difficult. He wondered if Mr. Evans found that the reaction tended to eliminate pin-holes or specks, as they called them, on the face of the chilled roll. He was greatly interested in Mr. Evans' ingot moulds. They all knew that the steel manufacturer preferred the composition of his ingot moulds controlled in such a way that the mould could be remelted in his steel furnace for the making of steel in the place of pig-iron. With a high-content carbon and low sulphur, one obtained a structure consisting principally of ferrite, with large graphite flakes, and the contraction and expansion that took place under heating caused cracking, etc., but at the same time, the fact that it was a graphite and ferrite structure helped to prolong the life of an ingot mould. He understood from Mr. Evans that the soda-ash treatment tended to reduce the size of the graphite, and yet at the same time Mr. Evans claimed that they could get 10 to 15 per cent. longer life with these ingot moulds. From one or two experiments he had conducted he had found that, if one had a lower carbon and a finer structure, the tendency was to get a reduced life owing to the fact that cracking set in prematurely.

Silicon, Sulphur and Segregation

MR. EVANS said that a soda slag should not be viscous if properly treated, but be dry. A likely cause was that insufficient limestone had been used. In regard to castings being affected by the lowering of the silicon, it had to be borne in mind that the loss of silicon more or less balanced the loss of sulphur. If they removed the silicon they tended to have more combined carbon. If they had a low-sulphur iron they needed a lower silicon content. In regard to the question of rolls, he must speak rather carefully, because roll treatment by soda ash was still only in the experimental stage, but he had never been able to understand why roll makers did not like to depend on a low silicon for getting their hardness. It had been demonstrated that they could get as hard a roll if they used low sulphur and a lower silicon than usual, and the important point about silicon was that it did not segregate. If they cast an iron containing anything over about 0.12 per cent. of sulphur, which was not a high percentage for rolls, he believed it was extremely difficult to get it evenly distributed. If Mr. Roxburgh knew how to do that he had solved the problem. He himself had never yet seen it done. In the diagrams of rolls that he had shown the hardness of the treated roll was definitely higher. If they took the extreme case and seriously lowered the silicon of grey iron, they increased the hardness very materially; actually they converted a machinable casting into an unmachinable casting. So far as he had mentioned rolls he had spoken from actual experiments carried out, and although there was some evidence that the removing of sulphur affected the depth of chill, that did not seem to be proving a serious matter in actual practice. He was anxious to collect information on this, and if Mr. Roxburgh carried out any experiments on rolls he would like to have the benefit of his results. So far they were getting very good results from treating rolls. So far as pin-holes were concerned he thought that soda ash definitely would help.

Ingot Moulds

He could not give them figures of actual tests carried out at steelworks on ingot moulds not under the control of his firm. He did not think that the question of expansion seriously affected the question raised. The increased life alluded to was probably attributable to the absence of very coarse graphite near the surface. It might be that a zone of finer graphite gave a better structure for heat resisting. Coarse graphite had a channelling effect along which oxidation might take place. As a rule, desulphurisation was not nearly so efficient when soda ash was added in the cupola. The use of soda ash in the cupola was, quite frankly, a compromise. Wherever possible the process should be carried out in the receiver or the ladle. There were cases where this method had to be departed from and where it would be impossible to spend any time in removing slag from the ladle. In that case, as a compromise, they carried out the treatment in the cupola. That did seem to ameliorate the properties of the casting, but it did not appreciably lower the sulphur unless a sufficient amount of limestone was used.

DR. J. G. A. SKERL said so far as he could gather most foundries were not worried with sulphur, but that did not do away with the necessity for the addition of soda ash. He had studied carefully one of the tables Mr. Evans had exhibited, which indicated a loss of silicon up to 16 per cent. That was an important matter. He thought that the loss of silicon would have a much greater effect than the loss of sulphur. The question of proper cupola control came into the question of soda-ash treatment. Mr. Evans had mentioned the point that 28 to 30 per cent. lime was a necessity in the cupola slag to get de-sulphurisation. That had been his (Dr. Skerl's) contention for many years, and he would be very interested if Mr. Evans would tell them what were the relative values of de-sulphurisation with soda-ash and limestone, starting, for example, with, say, 20 per cent. minimum of lime in the cupola slag. What would be the relative loss in sulphur due to the lime? He believed that the result would be rather astounding. Another difficulty that had presented itself in many foundries was the loss of temperature due to de-sulphurisation. Some foundries thought that the metal did not keep hot sufficiently long. Where there was a great loss of silicon the metal would tend to become more sticky and pasty, and would not run so well. An interesting point that Mr. Evans had brought up was that of the addition of plumbago. Many foundrymen liked to see the ganister they used for patching the cupolas of a dark shade, which may indicate the presence of carbon.

Loss of Temperature and Inefficiency

MR. EVANS said it was a fact that the loss of sulphur balanced the loss of silicon. He had no figures available on the relative desulphurisation reaction of soda-ash and limestone. If they increased the limestone charge in their cupola they would desulphurise whether they added soda-ash or not. Concerning the question of loss of temperature due to the treatment of cast iron with soda-ash it had to be remembered that they always lost temperature if they kept a ladle hanging about for a long time. He had been in foundries where it was complained that they were losing temperature, and the cause was usually found in the fact that the workmen carrying out the process were not sufficiently used to it and were not taking off the slag quickly enough. As against that, however, there had been definite cases where the metal had been shown to be hotter and more fluid after treatment with sodium carbonate.

Non-Ferrous Practice

MR. J. EMMOTT remarked that Mr. Evans had spoken about soda-ash in brass and bronze but had not referred to crucible. They found that crucibles had only lasted about 75 per cent. of the normal life.

MR. EVANS said he was afraid he had no definite information on the question of the treatment of non-ferrous metals. He believed they would experience serious difficulties in crucible. Whether they could be overcome by using crucible with a different structure or composition he was not in a position to say. It was possible that a solution of the problem might be found by giving crucibles a wash with some more refractory material on the inside. That was something upon which he hoped to carry out some experiments soon. There were some refractories that were admittedly very expensive, but it might be possible to justify the extra expense.

Low-Sulphur Rolls

Answering a point raised by Mr. E. J. Brown, MR. EVANS said it appeared to him that they would have to re-think the whole question of rolls, particularly as far as chilled rolls were concerned. The criterion of a roll being good or bad was not whether it was a ¾-in. chill or a 1½-in. chill. The real test was in regard to how long it stood up in service. The whole question was in the experimental stage at the moment. At present the indications were that a low-sulphur roll was giving better serivce.

Replying to Mr. S. Offiler, MR. EVANS said that the experiments to which he had alluded were carried out at a malleable-iron foundry making iron castings, where shrinkage cavities caused a great deal of trouble, but one had to be careful in estimating the amount of the contraction. It was possible to have cavities in castings that were not due to shrinkage.

MR. T. R. WALKER said he was very interested in what Mr. Evans had said about the reduction of non-metallic impurities in steel, and asked for more information on this point. He would like Mr. Evans to tell them what the evidence actually was as to the reduction. If the process

(*Concluded on page* 310)

Some Notes on the Production of Important Castings

The Wales and Monmouthshire Branch of the Institute of British Foundrymen held a special propaganda meeting at the Y.M.C.A. Buildings, Llanelly, on March 24, presided over by Mr. C. E. Richards. Mr. C. E. Williams, President of the Institute, was present, and spoke as to the need for greater activity on the part of South Wales founders by joining up with the Institute of British Foundrymen.

The Lecture Hall was packed to the doors, a large contingent of members having driven down from Cardiff and district. A most interesting lantern lecture was given by MR. E. LONGDEN on "Some Notes on the Production of Important Castings."

In thanking Mr. Clement and his Llanelly friends for the arrangements made, which included the provision of tea, MR. C. E. WILLIAMS spoke of the work of the Institute of British Foundrymen, stressing its value for the formation of friendships and the elimination of suspicion between one workshop and another. He then asked the secretary (Mr. McClelland) to outline the various grades of membership.

The BRANCH-PRESIDENT next called upon Mr. E. Longden to deliver his lecture.

MR. E. LONGDEN first expressed his appreciation of such interest consequent on the presence of such a large body of foundrymen, and said he proposed dealing with special classes of castings, and hoped that at least one or more aspects of the series might be of interest to everyone present.

In view of the meeting being of a propaganda nature he had refrained from completing a written Paper which he had at one time started to prepare, and therefore decided that much more ground could be covered by using a large number of representative illustrations by lantern slides with a short description of the salient features of the castings.

Throughout the lecture Mr. E. Longden emphasised the importance of details which it is extremely difficult to obtain from the general foundry worker, and stressed the influence of the gating systems, the effect of the mould materials on the appearance of a casting and the constitution and soundness of the metal composing the casting. The temperature and analyses of various metals were also linked up with the general technique of producing the many important castings described, which included the following remarks:—

Gas- and Oil-Engine Parts

Small important castings such as ramsbottom rings, valve heads and valve spindles were shown to illustrate the effect of various types of runner and riser gates and feeder headers on the casting. The employment of spray-iron gates and self-feeders were shown to be very effective in producing sound castings. It was necessary to avoid the use of the ordinary Vee-gates and rod-feeding with such castings.

If the small castings are mounted on plate or machine the formation of the shallow-spray ingates are arranged permanently on the pattern plate and are so far largely foolproof. Otherwise it is a constant vigil to retain the correct shapes, ratios and sizes of a runner and feeder gates. To ease this need for constant detailed supervisory attention, it is good practice to have available loose permanent metal spray ingate patterns which can be used for small jobbing castings.

A 7-cwt. oil-engine piston was shown poured through the body core by passing the metal through a ¾-in. dia. down-gate into a boss situated at the lowest point of the mould. The gudgeon bearings, it was explained, were densened by metal inserts located in the bearing cores.

A combination semi-diesel oil-engine cylinder weighing approximately 55 cwts. was shown to illustrate the application of top and bottom gating jointly. Metal first passes into the combustion-chamber section by a down-gate through the main-body core into which is built a sullage chamber and from which the metal runs into the mould cleanly and quietly through well-formed spray gates. When sufficient metal has entered the mould to fill above the combustion-chamber top, drop-gates suitably arranged around the bore core are then operated to complete the filling of the mould.

Steam-Engine Castings

Steam-cylinder covers were shown to be successfully dealt with when poured through horn-gates and the mould with the large flange uppermost. Slides illustrating moulding practice for a 60-cwt. steam cylinder showed that very satisfactory castings can be made by moulding with the cylinder bore either vertical or horizontal if a well-considered scheme of gating was practised. When casting with the bore horizontal the illustrations described how to pass clean metal of high temperature into the mould without turbulence. Firstly, the metal is poured into a well-formed pouring basin capable of holding about one-third of the metal required for the casting. The metal then passes down large in-gates 3 in. dia., the upper entrance having been closed by ball stoppers until a sufficient head of metal was present in the pouring basin. From the main down-gates the metal passed into a sullage chamber situated on the mould joint, and from this chamber a further set of down-gates approximately 60 per cent. of the area of the main gates allows the metal to run into a low point of the mould on the valve side through in-gates of slightly larger capacity than those which feed the same. Thereby clean metal, free from sullage and loose sand is admitted to the mould without turbulence. Self-feeder headers are located on the flanges and large bosses.

When pouring such cylinders vertically, metal enters the mould through top drop-gates arranged around the cylinder-bore core. In this instance it is necessary to allow a shrink and sullage head of from 6 in. to 9 in. in depth on the top side of the flange as-cast.

Centrifugal-Pump Body

The production of a 60-in. centrifugal-pump body was described to illustrate a system of producing a large core which could readily be relieved to allow the casting to contract without fracturing. A necessarily strong heavy core is built with the underside of the upper portion of the core supported by iron pillars resting on specially-arranged wedges. Shortly after the casting has solidified the mould around the outside of the top core is excavated and the core outlets exposed. Then a number of bricks are displaced on the inside of the core and the supporting pillars knocked down, allowing the whole of the upper surface of the core to collapse and free contraction of the casting to take place.

Hydraulic Cylinders and Rams

When illustrating the production of hydraulic cylinders and rams it was shown how important it was to provide suitable tackle and moulding equipment, without which such important castings could not be successfully produced. If suitable equipment was not forthcoming, a company would be well advised to contract out for the production of such castings with founders possessing the facilities and experience.

The meeting was very interested in the methods employed to produce a 20-ton cylinder from a short-segment pattern costing only about £2. The cheap-pattern work was possibly due to the provision of a machined moulding plate suitably arranged for locating pins and good standard machined section moulding boxes which can be built up to give any desired length of casting.

Since the mould and core are assembled vertically the handling of the 38-ft. length of core presents a problem. The core, after having been swept up in special refractory loam horizontally, must be turned up vertically to situate it in the mould. This cannot be done without casualties, and sometimes complete loss of a core following fractures or buckling of the core in handling. This difficult section of the work can be safely accomplished by the provision of a cast-iron cradle to which the core is seated and strapped when in a horizontal position. The cradle, with its attached core, is then safely turned up to a vertical position, using two cranes and placing in the corner of the casting pit. The core is freed from the cradle and can be handled safely in the vertical position.

The system of pouring disclosed the combination of bottom and top gating. The heavy impact of metal on the lower face of such a mould outlined would be fatal if top-drop gates alone were employed. The molten iron passes through a down-gate arrested at three points in its downward passage to the bottom of the mould, where it enters quietly. When about 4 tons of metal has entered at the bottom of the mould the top drop-gates are brought into action.

It was explained how necessary it was to produce a very strong core made by special refractory sand and composition to resist the penetrating effect of the molten iron at high pressure and turbulence. Many further examples of moulding practice were featured employing the systems of gating and mould construction already outlined.

The lecture ended with a description of test castings poured under varied conditions and with moulds made of different kinds of material. The powerful influence of mould materials was disclosed. The profound effect of such influences on the soundness and constitution of the metal was profusely illustrated by a large number of sketches and photographs.

DISCUSSION

MR. HIRD asked what mixture of sand was used for the slag-ladle splitting cores and bolt-hole cores.

MR. KELLY wanted to know the difference between denseners and chills.

MR. HOLBURY asked whether there was any weakness due to the use of densers in the test blocks. He referred to the possible migration and segregation of phosphide.

A representative from the Glanmor Foundry referred to the densening of the small castings, stating that in the casting of chilled rolls much more porosity occurred near the chill. How could this be avoided?

MR. MCCLELLAND asked, were the test castings shown with porous holes cast at a high or low temperature?

In reply, MR. E. LONGDEN stated that the sand mixture he used for the slag ladles was 25 per cent. mineral blacking, 25 per cent. ganister and 50 per cent. red sand, well milled together, with particular attention to the thorough drying of the cores. He had found of recent years that an effective mixture of refractory sand for such a purpose could be secured by using 75 per cent. foundry fettling-shop sand and 25 per cent. red sand at a ratio of one part of good-class core oil to 30 of sand, which should be well milled together. The mixture should be modified in the light of the quality of the sand used from the fettling shop and the new virgin sand available.

MR. HIRD thought the value of the mixture must be due to the oil, as he doubted the value of the use of sand from the fettling shop.

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OUTLINE OF THE SCHEME

An outline of the position of the Corby iron and steel project was given by Mr. A. C. Macdiarmid, chairman of Messrs. Stewarts and Lloyds, Limited, at the annual meeting of the company.

The operations are based on the ironstone deposits of Northamptonshire, of which Messrs. Stewarts and Lloyds own or control some 500,000,000 tons. Mr. Macdiarmid said that the company had quarried this ore and operated blast furnaces in this district for the production of pig-iron for many years, so that they had a wealth of practical experience and knowledge of these ore bodies and of local conditions pertaining to their mining and use. These ores were of a quality suitable for the manufacture of basic-Bessemer steel, provided that they were properly prepared and treated and smelted in blast furnaces of suitable design. Large tonnages of this quality of steel, which had advantages for the manufacture of certain important categories of tubes and other purposes, had been imported from the Continent for many years. Since with modern equipment the ore could be cheaply mined, treated and smelted, the new operation at Corby, which would be continuous from the ore to the finished tube, would result in the production of steel and tubes at an exceptionally low cost. To carry out their programme a complete modern plant was being installed for increasing the output of the mines, preparing and treating the ores and smelting them by modern methods. The blast-furnace plant was being remodelled, and at the same time the capacity of the furnaces was being increased. By-product coke ovens of the latest and most approved design were being installed, together with a by-product plant.

Flexibility, Low Cost, High Quality

The new basic-Bessemer steelworks, the chairman said, would incorporate the most approved features of modern practice, and the best available methods had been adopted for controlling the operations from the ironstone and coke to the finished steel ingot in order to ensure a uniform quality of high-grade steel. Open-hearth-quality steel would also be made, but the bulk of the output would be of Bessemer quality. The rolling mills had received special study for the purpose of combining flexibility with low cost of operation and high quality of product, and while they had been primarily designed to meet the requirements of the tube plants, they would be capable of supplying steel for other purposes at exceptionally low cost.

Maximum use would be made of all surplus gases from blast furnaces and coke ovens in the production of iron and steel. In addition, a substantial amount of gas would be sold to the neighbouring community. All by-products from the operation of the coke ovens and the steelworks would be recovered and prepared for the market by special equipment designed for this work. They were installing a new tube process designed to take full advantage of the integrated system of manufacture. This process was selected some time ago after a careful examination of possible alternatives, both in Europe and America. At that time it was still in a semi-developed state, but within recent months it had been thoroughly proved out. The adoption of this method would further reduce costs and improve the quality of their products.

Although the whole Corby plant was designed as a self-contained unit, its position in relation to their other plants was such as to provide an all-round flexible manufacturing programme, capable of adjustment to meet new conditions as they might arise. Within a few days the first of the new blast furnaces would be lighted, and at intervals during the rest of the year other sections would begin their activity. They were close on the time-table which they set before them to mark the respective stages in the development. Early in 1935 they hoped to be in full and successful operation. For the first time there would be installed in this country a complete, self-sufficient, balanced and integrated plant, using the latest and most efficient machinery to produce the finished tube by a continuous process from the raw material quarried in the immediate neighbourhood of the works. From their shareholders' point of view, they were confident of the wisdom of the project. They were satisfied it would place them in a commanding position in the world's markets, and he believed that they were also making a contribution to the well-being of the country as a whole.

Mechanical Properties of Steel at Low Temperatures

The liquefaction of gases has been developed to such an extent during recent years that investigators have directed much attention to, *inter alia*, the mechanical properties of steel at the extremely low temperatures which can be obtained by means of these liquefied gases. The behaviour of steel in these low-temperature ranges has, however, not been studied in very great detail, and it is interesting to note that G. GRUSCHKA in V.D.I.-Forschungsheft No. 364, just issued, has examined this behaviour of structural steels in relation to their composition, as well as the effect, if any, of alloy substances.

A series of impact tests at low temperatures showed that from the lowest temperatures realised up to about −50 deg. C. the impact value of these steels is comparatively small and practically constant, while above −50 deg. this value rises quickly to a maximum at around +100 deg. C., beyond which it again falls. The transition points between −50 and +100 deg. and between the maximum and minimum values of the curve are not well defined, a different behaviour being exhibited by each material. The variation in impact value with temperature determined the shape chosen for the test-pieces used in tensile tests, especially as the pieces hitherto used for these tests at low temperatures did not meet all practical requirements. A new shape of bar was therefore adopted, as well as two new apparatus for cooling the sample before and during the test and to ensure that the test-piece was maintained at a constant low temperature for as long as desired. The first cooling apparatus consisted of a thermostat indirectly cooled by a liquid-hydrocarbon compound, but owing to the marked precipitation of atmospheric moisture as ice in the container the temperature could not be lowered beyond −160 deg. Below this temperature, an oxygen cooler was used in which the fact that the boiling point rises with the pressure was utilised. By filling this apparatus with liquid oxygen, nitrogen, methane or other low-boiling gas, a range of low temperatures was obtained. The lowest temperature employed was the boiling point of nitrogen (−195 deg. C.).

Investigations were made on 12 kinds of steel, and several series of tests carried out to determine the effect of the carbon content, the manganese content and the addition of nickel on the mechanical properties at the low temperatures applied. It was found that with decreasing temperature the yield point and the tensile strength of carbon steels and also of nickel steels both increase, the linear relationship between strength and carbon content existing within normal temperature ranges also being true for these low temperatures. The curves for local contraction and elongation, however, showed discontinuities in different temperature ranges according to the composition of the steels in question. The addition of nickel had a marked effect as it lowered the temperature of discontinuity much under those of the carbon steels. This discontinuity indicates down to which temperature a carbon or nickel steel can be safely used for constructional purposes. In the contraction and elongation curves the discontinuity was so marked for all the steels investigated that definite maxima and minima could be readily determined as characteristic values.

MESSRS. RUSTON-BUCYRUS, LIMITED, Lincoln, have recently executed a repeat order from the River Ouse (Yorks) Catchment Board for a 21-B dragline, ordered as a result of the official tests and subsequent successful working of a similar machine delivered about a month before, on the big drainage scheme now being carried out by the River Ouse Catchment Board in the Yorkshire area. These 21-B draglines have unusually long working reaches, and are fitted with booms 60 ft. long. Each machine is Diesel-engine driven by a "Ruston" engine of 70 b.h.p.

Some Notes on the Production of Important Castings

(*Concluded from page* 304)

MR. E. LONGDEN replied that "the proof of the pudding was in the eating," and that he had used this mixture for 50 per cent. of the cores he was producing. If he had to make ingot moulds again, he would resort to building the cores in the oil sand described. To another question about the quality of the red sand used, he said that one would have to vary the amount of red sand according to its quality and the condition of the fettling-shop sand. In his case the fettling-shop sand contained not only sand from cores and adhering sand from the outside of the casting, but also fine cinder dust and blacking. For instance, if Mansfield red sand was used, he would reduce the increment of red sand to about 10 per cent.

MR. C. E. WILLIAMS asked what weight ingot mould would Mr. Longden suggest trying this mixture on and was informed that it would be sensible to commence on a small casting, progressing according to success.

MR. HIRD asked how much core oil should be used, and in reply the lecturer said that between 25 to 30 parts of sand to 1 of oil was quite safe, the higher limit being necessary for heavy-sectioned castings. These figures referred to volume and not weight.

Referring to the weakness due to the use of denseners by Mr. Holbury, MR. LONGDEN said that with metal as used for chilled rolls which was low in phosphorus he would not expect any weakness due to the difference in the rate of cooling between the chilled portion of the casting and that semi-chilled or unchilled sections in the neck and wobbler ends of the casting. When using denseners on large castings one had to face many hazards, and one must take into consideration many factors such as size, shape and condition of chills, location of in-gates in relationship to the position of the chills and the amount and temperature of the metal passing over the chills. The story of densening is too long a subject to reply to in a discussion.

The difference between a chill and a densener is one of degree and is all a matter of what one is attempting to produce. It is a chill when used for creating a surface of white iron as for chilled rolls and a densener when used for the elimination of general porosity and local porosity and generally closing the grain without sacrificing greyness in the metal fracture.

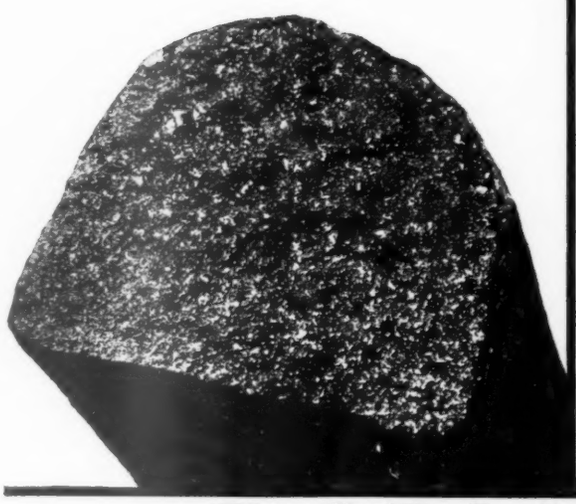
Pinholes in chilled rolls are related to the practice connected with the dressing of the chilled mould, or the temperature of the mould, the method of pouring, the composition or temperature of the metal. If the metal be poured too hot one could obtain a severe attack on the chill mould. The speed at which it is poured and the direction of the flow of the metal will help to clear the pinholes which form on the face, and the condition of the mould dressing is of primary importance as determined by its ingredients, and the temperature of the metal mould and mode of applying same.

Referring to the test-blocks, he stated that the temperature did not vary much. During the tests as many as six blocks made under different conditions were cast simultaneously from one ladle. There is a marked difference between the amount and position of porosity according to the temperature of pouring, as he hoped to prove at a later date.

MR. W. E. CLEMENT hoped that many members would result from the meeting, so that the Llanelly founders could pool their ideas and so help to improve their industry. The difficulties of the past would be forgotten if consultations took place, and it would be possible to make even still better castings in Llanelly if there was this interchange of ideas.

The meeting concluded with a hearty vote of thanks to Mr. Longden, proposed by MR. C. E. WILLIAMS, seconded by MR. W. E. CLEMENT.

XUM



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This Week's News in Brief

Trade Talk

JODHPUR RAILWAYS have placed orders with Hurst, Nelson & Company, Motherwell, for six bogie carriage underframes.

IT IS PROPOSED to purchase automatically-controlled rectifying apparatus, value £16,650, for use on the Sheffield tramways electricity supply.

THE TENDER OF Messrs. Hadfields, Limited, Sheffield, for manganese-steel points and crossings has been accepted by the Sheffield Transport Committee.

NYASALAND RAILWAYS, South Africa, have instructed P. & W. MacLellan, Glasgow, to proceed with the construction of a 60-ft. clear-span bridge.

MESSRS. FODENS, LIMITED, have despatched three Diesel wagons—the first to be shipped to West Africa—to Takoradi, on behalf of one of the mining companies.

THE PERUVIAN CORPORATION have placed an order with Messrs. Beyer, Peacock & Company, Limited, Manchester, for three oil-fired locomotives for the Central Railway of Peru.

ALL COMMUNICATIONS concerning Zimmermann moulding machines should be addressed in future to Zimmermann Machines, 37-38, Golden Square, London, W.1. Telephone: Gerrard 1051.

A PETITION FOR CONFIRMATION of the reduction of the capital of the Sheepbridge Stokes Centrifugal Castings Company, Limited, from £100,000 to £71,250 is to be heard before Mr. Justice Bennett on May 7.

MESSRS. WILLIAM BEARDMORE & COMPANY, LIMITED, Glasgow, have received an order for 1,000 sets of wheels and axles for the Indian State Railways. The order will provide increased working at the Parkhead works.

MESSRS. WILLIAM THOMSON & COMPANY (KINNING PARK), LIMITED, Glasgow, makers of pulley blocks, etc., have secured a contract from the Admiralty for the supply of worm-gear chain pulley blocks to the Royal dockyards for the current year.

AN ORDER for five locomotives has been secured by the Hunslet Engine Company, Limited, Leeds, from the Chinese Purchasing Commission under the Boxer Indemnity Scheme. This is the second order the company have received from the same source within a year.

AN ORDER has been placed with Messrs. Stothert & Pitt, Limited, Bath, by Messrs. Bowater's Mersey Paper Mills, Limited, Ellesmere Port, for the supply and erection of five portable electric crank-level luffing grabbing cranes, each capable of lifting 2½ tons at a radius of 56 ft.

CONTRACTS FOR THE CONSTRUCTION of two sugar factories for India have been secured by Blairs, Limited, Glasgow. The placing of these and similar orders with West of Scotland firms has been awaited for some time. Tenders for still further business of this nature are under consideration.

THE MANCHESTER CITY COUNCIL has approved the acceptance by the Electricity Committee of the tender of Messrs. Ferguson, Pailin, Limited, of Openshaw, Manchester, for the manufacture and erection of new electrical switchgear for the Stuart Street power station. The value of the contract is put at about £140,000.

MESSRS. COLVILLES, LIMITED, are shortly to erect at their Clyde ironworks a complete modern electrical precipitation plant for cleaning blast-furnace gas. This will be the first gas-cleaning plant to be operated in Scotland. It is anticipated that this development will be carried out without interrupting the present production at these works.

THE RECENT ORDERS for locomotives secured by the North British Locomotive Company, Limited, Glasgow, have resulted in a number of employees in the firm's Hyde Park Works, who were formerly engaged in the Queen's Park Works, Polmadie, being transferred to the latter, where part of the orders will be completed. Men are being engaged at the Hyde Park Works daily, as they are required, in the various departments, and it is expected that other workers will be taken on in the erecting department next month.

NEGOTIATIONS ARE PROCEEDING for the formation of a finance company to assist in particular small new industries in Scotland. Sir James Lithgow made this disclosure when presiding at a meeting in Glasgow of the Chairman's Committee of the Scottish National Development Council. As the appeal to subscribers to the company would be on an altruistic basis as distinct from a high yield on their investments, there were obvious difficulties in the way, but he was hopeful that sufficient support would be forthcoming to enable the company to be formed.

AS PREVIOUSLY ANNOUNCED, the Excelsior Iron and Steel Works at Wishaw has changed hands, and the new firm officially took control on May 1. The chief members of the new firm are Mr. T. B. Corbett, of Metal Industries, Limited, and Mr. Tom Craig, of Colvilles, Limited. The latter is a son of Mr. John Craig, chairman of Messrs. Colvilles, Limited, and Mr. Corbett is a son-in-law. The works have been purchased as a going concern, and all the present range of manufactures, consisting of sheets, strips, hoops, washers, rivets, nails and wire, will be continued, and in addition the manufacture of safety-razor blades. Mr. Corbett, who is a native of the district, was in the employ of the Excelsior Iron and Steel Works as a young man, and later was employed with Messrs. David Colville & Sons, Limited, as chief of purchasing department. He transferred as commercial manager to Metal Industries, Limited, a few years ago. He and Mr. Craig will be actively associated with the new concern.

LORD RUTHERFORD, speaking at the annual dinner of the Chemical Engineering Group, held at the Waldorf Hotel, London, on April 27, said that at bottom, industry depended on the proper application of science. The greater part of our industries were only half awake to this fact. It must be realised, especially in this era of economic nationalism, that there was going to be a very keen and very severe struggle for trade throughout the world, and the nation which had a strong and well-balanced scientific background would have the advantage. It was more than ever important that we should have scientifically-minded industry. Those who managed industry, even if they were not scientific experts, should, at any rate, be scientifically minded. The Department of Scientific and Industrial Research was playing its part in this connection, and during the coming year the Government had supported the work of the Department by granting extra funds in order that the work of the research associations might be broadened, especially in those cases of scattered industries which were operating in such small units that they could not deal with their own research work individually. In this way he hoped that it would be possible, given time, for the Department to bring the industries of the country into such a position that they could stand against the competition which was inevitably coming and which would increase in the next few years.

Company Reports

Glenfield & Kennedy, Limited.—Final dividend of 5 per cent. on the ordinary shares, making 7 per cent.

Park Gate Iron & Steel Company, Limited.—The directors recommend a dividend of 2 per cent. after writing off £35,000 for depreciation and placing £10,000 to reserve.

Ransomes & Rapier, Limited.—The directors propose to transfer from the reserve fund £11,056, which, with the carry forward from the last account, will leave a disposable balance, after allowing for all outgoings, depreciation, interest on debentures, etc., of £1,608. The preference dividend takes £700, and £908 is carried forward.

Contracts Open

Sheerness, May 11.—Pumping plant, for the Urban District Council. The Surveyor, Council Offices, Sheerness.

Edinburgh, May 17.—750 tons of cast-iron pipes, for the Town Council. The Water Engineers, 29, Waterloo Place, Edinburgh.

Australia, June 18.—Electrically-driven centrifugal pump, for the Melbourne City Council. The Department of Overseas Trade. (Reference G.Y. 13,707.)

Burton Joyce, May 14.—Supply and erection of pumping plant, for the Nottingham Corporation Water Department. Mr. F. W. Davies, engineer and general manager, Water Department, Castle Boulevard, Nottingham. (Fee £3 3s., returnable.)

Personal

MR. S. H. MENZIES and DR. G. E. K. BLYTHE have been elected directors of the Buell Combustion Company, Limited.

MR. SAM MAVOR, of Messrs. Mavor & Coulson, Limited, Glasgow, has been appointed a member of the Standing Committee of the Council for Art and Industry in Scotland.

MR. JAMES MORGAN has received a presentation on retiring after serving for 54 years with Messrs. Stewarts and Lloyds, Limited, at their Coombs Wood Works, Halesowen.

AN INTERESTING CEREMONY took place in the counting-house department of Carron Company, Falkirk, last week, when, at the close of the day's work, a number of the staff met to honour Mr. David Niven on the occasion of his retirement after fifty years' service with the company. Mr. J. G. Thomson presided, and Mr. Peter Simpson presented Mr. Niven with a wireless set and case of pipes subscribed for by his fellow-workers.

A PLEASING LITTLE FUNCTION took place in the warehouse department of Messrs. Mitchell Russell & Company, Limited, Chattan Foundry, Bonnybridge, last week, when Mr. William Crane was met by his colleagues and made the recipient of gifts to mark the occasion of his marriage. Mr. R. Niven, departmental manager, made the presentation, and expressed on behalf of the subscribers wishes for Mr. Crane's future happiness.

ON THE REOPENING of the naval yard at Walker-on-Tyne, Mr. A. J. Hendin has been appointed special director of Messrs. Vickers Armstrongs, Limited, and in charge of the shipyard there. He will be directly responsible to Mr. J. Callander, who will continue as general manager in Barrow, and will in future be responsible for the administration of both establishments to the managing director, Commander C. W. Craven. Mr. Hendin was formerly the shipbuilding manager and a director of the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow.

Wills

BRADLEY, J. B., of Messrs. Bradley Bros., of Dudley £75,254

WESTGARTH, TOM, of Hessle, Yorks, managing director of Messrs. Richardsons, Westgarth & Company, Limited ... £9,970

BANISTER, G. H., formerly director of the Naval Construction Works of Messrs. Vickers, Limited, at Barrow-in-Furness £33,766

BRECKNELL, H. E. F., of Keynsham, engineer, formerly managing director of Messrs. Brecknell, Munro & Rogers, Limited, Bristol £16,334

Obituary

MR. FRANK H. SHAW, of the London office of Messrs. William Jacks & Company, died recently, aged 66.

MR. THOMAS DRAPER, who died at his home in Leeds on April 28, was in his 83rd year, and had been associated with the development of the light-castings section of the engineering industry in Leeds since he left Falkirk fifty years ago to join the Mathiesons at their foundry. He subsequently became a director of the firm which is now known as Wilsons & Mathiesons, Limited, of Armley. He retired from the directorate about four years ago.

THE ANNOUNCEMENT of the death of Mr. Walter D. Wood, the President of R. D. Wood & Company, of Philadelphia, will be received with deep sorrow by his many friends on this side of the Atlantic. Mr. Wood, who attained the ripe old age of 84, was until the last few years a regular visitor to this office. His firm, which was established in 1803 by his father, regularly bought supplies of pig-iron from England. Mr. Wood devoted much time and energy to the creation of internationally-unified acceptance tests for cast iron and the purchase of pig-iron to compositional tolerances. From 1909 to 1916 Mr. Wood served as a Vice-President of the American Foundrymen's Association, and held membership in numerous other technical societies. With his passing, the foundry industry has lost a member whose charm and courtesy were reminiscent of the best type of Victorian culture.

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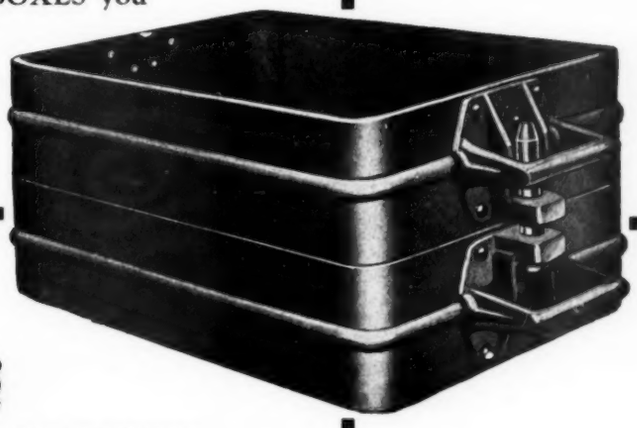

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BEDFORD

Raw Material Markets

Consumption of pig-iron in this country remains heavy, and another blast furnace has been started on the North-East Coast. Buying of semi-finished steel has fallen off, the requirements of many works being fully covered by long-term contracts, but good tonnages are being despatched by the producers. Continental competition in this department has become more pronounced lately. Conditions remain uneven in the finished-steel market, but generally a more hopeful tendency is in evidence. It is understood that plans are under consideration for Government assistance of the shipping and shipbuilding industries, which, if approved, should prove a powerful stimulus to the recovery of trade in the North.

Pig-Iron

MIDDLESBROUGH.—Apart from export trade, which remains very limited, the Cleveland iron market is quite well placed at the moment. Local consumption is heavier than for some years, and despatches to Scotland have also been maintained at a good level. The current output is fully taken up and, as stocks are down to the bare working level, any increase in the demand would entail the immediate re-lighting of additional furnaces. It is understood that one or two furnaces are, in fact, ready for operation as soon as circumstances warrant this step. No. 3 Cleveland G.M.B. is available at 67s. 6d. per ton delivered in the Middlesbrough area, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk, and 70s. 3d. per ton delivered Glasgow. No. 4 foundry and No. 4 forge are quoted 1s. per ton less than the foregoing, and No. 1 foundry grade is 2s. 6d. more than No. 3.

Although there are now ten furnaces producing East Coast hematite, the disposal of the output is fully assured by the heavy consumption locally and in Sheffield and the Midlands. Despatches to South Wales have been slightly smaller than usual. Business is being done at the new "delivered" prices, which are based on East Coast No. 1 hematite at 68s. per ton delivered Middlesbrough.

LANCASHIRE.—There has been rather a lull in buying of pig-iron, due to the fact that the majority of users are well booked at least as far as June or July. Specifications are coming through at a satisfactory rate. For delivery to users in Lancashire, Derbyshire, Staffordshire and North-East Coast brands of No. 3 iron are all quoted on the basis of 74s. per ton, with Northampton at 72s. 6d., Derbyshire forge at 69s., Scottish foundry at about 82s. 6d., East Coast hematite at 76s. for No. 1 and 75s. for No. 3, both unbroken, and about 80s. 6d. for West Coast hematite.

MIDLANDS.—There is a good call for the ordinary grades of foundry iron in this area, especially from the light-castings makers. Engineering iron is also in improving demand. Present quotations, for delivery in this district, are 67s. 6d. per ton for No. 3 Northants and 71s. for Derbyshire, Staffordshire and Lincolnshire No. 3, a graduated rebate being offered to large consumers. Scottish No. 3 is quoted at about 85s. per ton delivered this area and irons in the low-phosphorus category range from 81s. to 85s., with medium-phosphorus pig between 70s. and 80s. per ton, whilst for special engine work, etc., where refined iron is used, £5 15s. to £6 15s. are the ruling figures. At this juncture, not a great deal of contracting forward is to be observed, either for common or special irons, but by the end of the month there should be a change in this respect, as many contracts will shortly expire.

SCOTLAND.—The paucity of the demand for Scottish foundry iron is still marked, the recent changing-over of a furnace from foundry to basic being proof of this. Quotations are unchanged at 70s. per ton f.o.t. furnaces for No. 3, with 2s. 6d. extra for No. 1. Activity is maintained in the light-castings trade. Cleveland iron continues to be quoted at 67s. 3d. f.o.r. Falkirk and 70s. 3d. f.o.r. Glasgow for No. 3 foundry.

Coke

Foundry-coke quotations, while so far exhibiting no change, have a very firm tendency, and the producers are not willing to sell far ahead. Current prices in the South Staffordshire area are as follow:—Best Durham coke, 36s. 6d. to 40s.; other grades, 34s. to 35s.; Welsh, 36s. to 45s.; Scottish coke, about 41s. per ton; delivered Midland points.

Steel

Active conditions continue to rule in the steel markets, and practically all departments of the industry are busy, although there is some irregularity in the rate of operations between the different sections. Business in semi-finished steel is still quiet, but consumers are taking good deliveries, and the works producing this material are well employed. Recently, Continental competition in the home market has been more noticeable, although the quantities involved have not been important. In the finished-steel department, the recent good demand has been maintained, and the works producing shipbuilding steel have sufficient orders on their books to keep them busy for some time. The lighter branches of the trade are also well occupied, and some encouragement has been afforded lately by an increase in the volume of inquiry from overseas.

Scrap

There is a better demand for cast-iron scrap in the Cleveland market, but there has been little alteration in quotations, which remain at 50s. per ton for heavy metal, 53s. for machinery metal and 46s. for light cast-iron scrap. There is a consistent demand in the Midlands, where heavy machinery metal is offered at 55s., good heavy pipe and plate scrap at 50s., and clean light scrap at 47s. 6d., all delivered works. Prices are weaker in Scotland. In South Wales there is only a limited demand for good cast-iron machinery scrap for foundry purposes, at about 50s. to 52s. 6d., but light cast-iron scrap is displaying more activity at 41s. to 42s. 6d.

Metals

The base-metal markets have shown a distinctly weaker tendency during the past week, the decline in prices being almost entirely due to artificial influences, *i.e.*, the raising of the tin quota, the institution of government control of the copper industry in the United States, German restrictions on metal imports and consumption, etc. This type of interference with the natural laws of supply and demand makes trading conditions very difficult, and the outlook is decidedly obscure at the moment.

Copper.—Consumption of copper in this country has been maintained at a satisfactory rate, and prospects in this direction are reasonably good. The Continental copper trade is, however, in a very involved state at the moment, and trading has been restricted. Import restrictions in Germany and Italy and uncertain foreign exchanges have combined to make business very difficult. The market is also still largely in the dark as regards the situation in the United States since the introduction of the Copper Code. In view of these factors, it is not surprising that quotations generally have shown a downward tendency. There was, however, a substantial recovery on Wednesday.

Daily quotations:—

Cash.—Thursday, £32 11s. 3d. to £32 12s. 6d.; Friday, £32 10s. to £32 11s. 3d.; Monday, £32 5s. to £32 6s. 3d.; Tuesday, £32 3s. 9d. to £32 5s.; Wednesday, £32 18s. 9d. to £33.

Three Months.—Thursday, £32 16s. 3d. to £32 17s. 6d.; Friday, £32 13s. 9d. to £32 15s.; Monday, £32 10s. to £32 11s. 3d.; Tuesday, £32 7s. 6d. to £32 8s. 9d.; Wednesday, £33 3s. 9d. to £33 5s.

Tin.—On May 2 the International Tin Committee made an increase in the tin quota of 10 per cent., to date from the first of the month. That an increase in supplies was urgently needed is shown by the fact that the world's visible supply of tin has now decreased to about 17,000 tons, as the result of improving consumption and the restriction of supplies, although twelve months ago world stocks amounted to 42,272 tons. Following the I.T.C.'s announcement, tin quotations receded from the very high level they had recently reached. In this respect, Messrs. Rudolf Wolff say "It is felt that the highest prices for tin have now been seen, and that values are more likely to be on a lower basis, say between £225 and £235, without any violent fluctuations."

Market prices:—

Cash.—Thursday, £233 15s. to £234; Friday, £234 10s. to £234 15s.; Monday, £235 7s. 6d. to £235 12s. 6d.; Tuesday, £235 5s. to £235 7s. 6d.; Wednesday, £235 15s. to £236.

Three Months.—Thursday, £231 15s. to £232; Friday, £232 5s. to £232 10s.; Monday, £232 7s. 6d. to £232 10s.; Tuesday, £232 to £232 2s. 6d.; Wednesday, £232 10s. to £232 15s.

Spelter.—Conditions in this market are practically unchanged. Prices have at times been slightly easier, largely in sympathy with the general trend. The European brassworks remain busy, but the galvanising trade has yet to make any recovery. There has, however, been a slightly improved demand for zinc sheets.

Day-by-day prices:—

Ordinary.—Thursday, £14 16s. 3d.; Friday, £14 15s.; Monday, £14 13s. 9d.; Tuesday, £14 16s. 3d.; Wednesday, £14 18s. 9d.

Lead.—Little fluctuation has taken place in prices, there being no alteration in market conditions. The general tendency has been slightly downwards.

Market fluctuations:—

Soft Foreign (Prompt).—Thursday, £11 6s. 3d.; Friday, £11 3s. 9d.; Monday, £11 12s. 6d.; Tuesday, £11 1s. 3d.; Wednesday, £11 1s. 3d.

Uses of Sodium Carbonate in Foundry Practice

(*Concluded from page* 303)

actually did remove non-metallic impurities it might prove of great assistance to those interested.

Mr. Evans said that on the question of the removal of non-metallic inclusions from steel, he thought he had made it clear in the lecture that he referred to steel made by the Tropenas process, in which the iron was treated—scavenged, as it were—before blowing in the converter. The evidence was purely that of the microscope.

Mr. S. Leetch said that there were steel foundries having to work to specification where 0.06 per cent. sulphur was the maximum, and he would think that most steel foundries had an average of 40 per cent. scrap, due to feederheads. It was used up again. If those foundries were told to see that their sulphur did not exceed 0.06 per cent., would the use of soda-ash outweigh the trouble of having to go from the cupola back into the ladle and then back again into the converter? Did they get a much better casting by the use of soda-ash?

A vote of thanks was accorded Mr. Evans on the proposition of Mr. C. D. Pollard, seconded by Mr. T. A. Oxley.

Widmanstätten Structure

At a meeting of the American Institute of Mining and Metallurgical Engineers held in New York recently, Messrs. R. F. Mehl and D. W. Smith read a Paper on "The Gamma-Alpha Transformation in Pure Iron." We append the authors' discussion of results. It seemed clear from the evidence obtained in the study of martensite and of the Widmanstätten figure in slowly-cooled hypoeutectoid steels that pure iron must show a crystallographically identical behaviour. Such, indeed, will doubtless often be found in alloys in which transformations occur that find their origin in allotropic transformations; in such cases the orientation relationships in the alloys may often be predicted from those determined for the allotropic transformation in the pure metal and *vice versa*. If, however, solid-solution formation in the participating phases alters lattice dimensions greatly it is quite possible that increasing solid-solution formation may see the initiation of a new and separate crystallographic process as new and preferable lattice-transformation mechanisms become possible. In the steels carbon alters the dimensions of γ iron only slightly, and α Fe dissolves but little carbon with an inappreciable alteration in its dimensions, and thus a common mechanism is preferable for both steels and pure iron. The apparent change in the crystallographic mechanism of the precipitation of $CuAl_2$ from the solid solution of Cu in Al upon increasing Cu content may be an example of the effect of changes in lattice dimensions, in this case upon a mechanism greatly sensitive to a change in lattice dimensions.

COLD BLAST PIG IRON

for best quality Chilled Castings, including alloy Chilled Iron,★ and high-class Engineering Castings.

★ *"In the production of alloy chilled iron . . . . for preference a substantial proportion of the charge would consist of low sulphur-content cold-blast iron."* W. T. Griffith, M.Sc., FOUNDRY TRADE JOURNAL, April 12, 1934.

THE EARL OF DUDLEY'S ROUND OAK WORKS, LTD.,
BRIERLEY HILL, STAFFS.
Brand: "DUD·L.N.F'ces·DUD"

M. & W. GRAZEBROOK,
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THE LOW MOOR IRON CO., LTD.,
NEW WORKS, LOW MOOR,
BRADFORD - YORKSHIRE.
Brand: "LOWMOOR C.B."

MAKERS OF GENUINE COLD BLAST PIG IRON

RAW MATERIALS—PRICE LIST

(Wednesday, May 9, 1934)

COPPER

	£	s.	d.
Standard cash	32	18	9
Three months	33	3	9
Electrolytic	35	15	0
Tough	34	15	0
Best selected	35	5	0
Sheets	62	0	0
India	44	5	0
Wire bars	36	5	0
Ingot bars	36	5	0
H.C. wire rods	38	10	0
Off. av. cash, April	33	10	10½
Do., 3 mths., April	33	5	8¼
Do., Sttlmnt., April	33	0	10½
Do., Electro, April	36	5	9
Do., B.S., April	36	3	1½
Do., wire bars, April	36	10	9
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7¾d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£	s.	d.
Standard cash	235	15	0
Three months	232	10	0
English	236	5	0
Bars	237	5	0
Straits	238	0	0
Australian	237	15	0
Eastern	235	0	0
Banca (nom.)	239	5	0
Off. av. cash, April	239	6	0
Do., 3 mths., April	237	13	8¼
Do., Sttlmt., April	239	6	3

SPELTER

	£	s.	d.
Ordinary	14	18	9
Remelted	15	0	0
Hard	12	2	6
Electro 99.9	17	12	6
English	15	10	0
India	14	0	0
Zinc dust	17	0	0
Zinc ashes	3	5	0
Off. aver., April	15	1	1⅞
Aver. spot, April	14	18	3¾

LEAD

	£	s.	d.
Soft foreign ppt.	11	1	3
Empire	11	6	3
English	12	10	0
Off. average, April	11	12	11½
Average spot, April	11	10	0

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	10	0
Do., V.M. ex whse.	23	0	0
Rods	29	0	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	42	0	0	to	43	0	0
Chinese, ex-whse.					36	0	0
Crude					25	0	0

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	10	10	0	to	10	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	13 0 0
75%	18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	32 0 0
4/6% car.	23 0 0
6/8% car.	21 12 6
8/10% car.	21 12 6
Ferro-chrome—	
Max. 2% car.	37 10 0
Max. 1% car.	38 15 0
Max. 0.70% car.	42 0 0
70%, carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	13	6	to	2	15	0
Bundled steel and shrngs.	2	2	6	to	2	7	6
Mixed iron and steel					2	10	0
Heavy cast iron	2	7	0	to	2	8	0
Good machinery	2	10	0	to	2	12	6
Cleveland—							
Heavy steel	2	7	6	to	2	10	0
Steel turnings					1	17	6
Cast-iron borings					1	7	6
Heavy forge					2	10	0
W.I. piling scrap					2	5	0
Cast-iron scrap	2	10	0	to	2	13	0
Midlands—							
Light cast-iron scrap					2	7	6
Heavy wrought iron					3	0	0
Steel turnings, f.o.r.					1	13	0
Scotland—							
Heavy steel	2	10	0	to	2	11	3
Ordinary cast iron					2	13	6
Engineers' turnings					2	1	6
Cast-iron borings	2	0	0	to	2	1	3
Wrought-iron piling					2	12	6
Heavy machinery	2	16	0	to	2	16	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	19	10	0
Lead (less usual draft)	10	0	0
Tea lead	7	10	0
Zinc	9	10	0
New aluminium cuttings	70	0	0
Braziery copper	24	0	0
Gunmetal	25	0	0
Hollow pewter	155	0	0
Shaped black pewter	110	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	80/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	12	6	to	9	15	0
Nut and bolt iron	7	5	0	to	8	0	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					13	15	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	2	6	to	8	10	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					8	12	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates	12	5	0	to	12	10	0
Hoops (Staffs)	10	10	0	& up.			
Black sheets, 24g. (4-t. lots)					10	10	0
Galv. cor. shts. (,,)					13	0	0
Galv. flat shts. (,,)					13	10	0
Galv. fencing wire, 8g. plain					14	10	0
Billets, soft					5	10	0
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	0	0	to	5	5	0
Tin bars					5	0	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	13.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	17.50
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	38.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.90
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.25
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	17/3 to 17/6
,, 28×20 ,,	34/6 to 35/-
,, 20×10 ,,	24/6 to 24/9
,, 18¾×14 ,,	18/- to 18/3
C.W. 20×14 ,,	15/- to 15/3
,, 28×20 ,,	31/3 to 31/6
,, 20×10 ,,	21/6 to 21/9
,, 18¾×14 ,,	15/3 to 15/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.	
May	3 ..	32	11	3	dec. 6/3
,,	4 ..	32	10	0	,, 1/3
,,	7 ..	32	5	0	,, 5/-
,,	8 ..	32	3	9	,, 1/3
,,	9 ..	32	18	9	inc. 15/-

Electrolytic Copper

		£	s.	d.	
May	3 ..	35	12	6	dec. 2/6
,,	4 ..	35	10	0	,, 2/6
,,	7 ..	35	5	0	,, 5/-
,,	8 ..	35	5	0	No change
,,	9 ..	35	15	0	inc. 10/-

Standard Tin (cash)

		£	s.	d.	
May	3 ..	233	15	0	dec. 95/-
,,	4 ..	234	10	0	inc. 15/-
,,	7 ..	235	7	6	,, 17/6
,,	8 ..	235	5	0	dec. 2/6
,,	9 ..	235	15	0	inc. 10/-

Tin (English ingots)

		£	s.	d.	
May	3 ..	234	5	0	dec. 100/-
,,	4 ..	235	0	0	inc. 15/-
,,	7 ..	236	0	0	,, 20/-
,,	8 ..	235	15	0	dec. 5/-
,,	9 ..	236	5	0	inc. 10/-

Spelter (ordinary)

		£	s.	d.	
May	3 ..	14	16	3	No change
,,	4 ..	14	15	0	dec. 1/3
,,	7 ..	14	13	9	,, 1/3
,,	8 ..	14	16	3	inc. 2/6
,,	9 ..	14	18	9	,, 2/6

Spelter (Electro, 99.9 per cent.)

		£	s.	d.	
May	3 ..	17	10	0	No change
,,	4 ..	17	8	9	dec. 1/3
,,	7 ..	17	7	6	,, 1/3
,,	8 ..	17	10	0	inc. 2/6
,,	9 ..	17	12	6	,, 2/6

Zinc Sheets (English)

		£	s.	d.	
May	3 ..	23	10	0	No change
,,	4 ..	23	10	0	,, ,,
,,	7 ..	23	10	0	,, ,,
,,	8 ..	23	10	0	,, ,,
,,	9 ..	23	10	0	,, ,,

Lead (English)

		£	s.	d.	
May	3 ..	12	15	0	No change
,,	4 ..	12	10	0	dec. 5/-
,,	7 ..	12	10	0	No change
,,	8 ..	12	10	0	,, ,,
,,	9 ..	12	10	0	,, ,,

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	1 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 9	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 0
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	12 10 0	12 2 3½
1930	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1931	12 10 0	12 10 0	12 10 0	12 8 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 3 2
1932	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0
1933	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0
1934	12 0 0	12 0 0	12 0 0	12 0 0	—	—	—	—	—	—	—	—	—

* No quotation available.

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TENDER

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

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Tender No.

1.—Bricks, Firebricks, Cement, etc.
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9.—Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, etc.
12.—Fuel Oil, Oil (Lubricating), Kerosene, Motor Spirit, Greases, etc.
19.—Iron, Brass, Gunmetal and other Castings.
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22.—Timber.
23.—Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained from the Acting Chief Engineer by personal application at the Offices of the Board (Room 155) or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the Form of Tender, must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Wednesday, May 16, 1934.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C.1.
April 30, 1934.

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Brearley Type Disintegrators.

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Hand and Pneumatic Types.

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16-ton capacity Stevenson Crane Ladle.
15-ton capacity Stevenson Crane Ladle.
12-ton capacity Evans Crane Ladle.
10-ton capacity Evans Crane Ladle.
40 smaller Ladles in stock.
Price £2 per ton capacity.
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